Clemson University
3 1604 011 399 302

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

# MINERAL RESOURCES

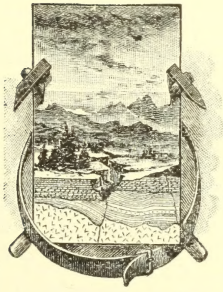
OF THE

# UNITED STATES

CALENDAR YEAR

1911

PART I—METALS



Clemson College Library
Government Publications

WASHINGTON
GOVERNMENT PRINTING OFFICE
1912

Digitized by the Internet Archive
in 2013

http://archive.org/details/mineralresources011911

# CONTENTS.


| | Page. |
|---|---|
| Mineral products of the United States: Review of conditions and output in 1910 and 1911, by Edward W. Parker | 7 |
| Summary of mineral production in the United States in 1911, compiled by W. T. Thom | 91 |
| Metals and metallic ores in 1910 and 1911, by H. D. McCaskey | 113 |
| Iron ore, pig iron, and steel, by Ernest F. Burchard | 119 |
| Iron-ore industry of United States | 120 |
| Production by States | 122 |
| Lake Superior district | 132 |
| Foreign trade | 136 |
| Cuba | 139 |
| World's production of iron ore | 140 |
| Prospecting for iron ore | 140 |
| Iron and steel industry of United States | 154 |
| Production of pig iron by States | 154 |
| Production of steel | 165 |
| Iron-ore reserves of Michigan, by C. K. Leith | 175 |
| Manganese and manganiferous ores, by Ernest F. Burchard | 181 |
| Manganese ore | 191 |
| Production | 191 |
| Manganiferous ores | 197 |
| Manganiferous zinc residuum | 198 |
| Ferromanganese and spiegeleisen | 199 |
| Uses of manganese | 202 |
| Notes on manganese | 202 |
| Gold, silver, copper, lead, and zinc in the United States in 1911 | 209 |
| Prefatory note | 209 |
| Gold and silver, by H. D. McCaskey | 211 |
| Production | 211 |
| World's production | 213 |
| Imports and exports | 218 |
| Mines report | 219 |
| Copper, by B. S. Butler | 255 |
| Production | 262 |
| Imports and exports | 309 |
| Consumption | 310 |
| Lead, by C. E. Siebenthal | 315 |
| Production | 316 |
| Consumption | 341 |
| Zinc, by C. E. Siebenthal | 353 |
| Production | 354 |
| World's production | 377 |
| Consumption | 385 |
| Cadmium, by C. E. Siebenthal | 399 |
| Gold, silver, copper, lead, and zinc in the Western States (mine production) | 403 |
| Introduction, by H. D. McCaskey | 403 |
| Alaska, by A. H. Brooks | 406 |
| Arizona, by V. C. Heikes | 420 |
| California, by Charles G. Yale | 462 |
| Colorado, by Charles W. Henderson | 505 |
| Idaho, by C. N. Gerry | 570 |
| Montana, by V. C. Heikes | 602 |
| Nevada, by V. C. Heikes | 646 |
| New Mexico, by Charles W. Henderson | 702 |
| Oregon, by Charles G. Yale | 721 |
| South Dakota, by Charles W. Henderson | 734 |
| Texas, by Charles W. Henderson | 739 |
| Utah, by V. C. Heikes | 740 |
| Washington, by C. N. Gerry | 778 |
| Wyoming, by Charles W. Henderson | 788 |

Page.
Silver, copper, lead, and zinc in Central States (mine production) ..... 793
Introduction by J. P. Dunlop ..... 793
Arkansas, by J. P. Dunlop ..... 798
Illinois, by J. P. Dunlop ..... 801
Iowa, by J. P. Dunlop ..... 805
Kansas, by J. P. Dunlop ..... 806
Kentucky, by J. P. Dunlop ..... 810
Michigan, by B. S. Butler ..... 811
Missouri, by J. P. Dunlop ..... 826
Oklahoma, by J. P. Dunlop ..... 857
Wisconsin, by J. P. Dunlop ..... 863
Gold, silver, copper, lead, and zinc in the Eastern States (mine production), by H. D. McCaskey ..... 873
Alabama ..... 877
Georgia ..... 878
Maine ..... 880
Maryland ..... 880
Massachusetts ..... 880
New Hampshire ..... 881
New Jersey ..... 881
New York ..... 881
North Carolina ..... 882
Pennsylvania ..... 884
South Carolina ..... 885
Tennessee ..... 885
Vermont ..... 887
Virginia ..... 887
Quicksilver, by H. D. McCaskey ..... 889
Bauxite and aluminum, by W. C. Phalen ..... 923
Tungsten, by Frank L. Hess ..... 941
Vanadium, by Frank L. Hess ..... 949
Uranium, by Frank L. Hess ..... 952
Titanium, by Frank L. Hess ..... 954
Molybdenum, by Frank L. Hess ..... 955
Nickel, by Frank L. Hess ..... 956
Cobalt, by Frank L. Hess ..... 959
Tantalum, by Frank L. Hess ..... 960
Tin, by Frank L. Hess ..... 963
Antimony, by Frank L. Hess ..... 973
Bismuth, by Frank L. Hess ..... 976
Selenium, by Frank L. Hess ..... 977
Chromic iron ore, by W. C. Phalen ..... 979
Platinum and allied metals, by Waldemar Lindgren ..... 987
Index ..... 1005

# ILLUSTRATIONS.


Page.

FIGURE 1. Curve showing value of mineral products in the United States, 1880–1911 ..... 109
2. Curve showing the production of iron ore, pig iron, and steel in the United States, 1870–1910, in long tons ..... 121
3. Curve showing production of pig iron in the United States, in long tons, in 1907, 1908, 1909, 1910, and 1911, by months ..... 157
4. Map showing iron-ore reserves of Michigan in 1911 ..... 175
5. Diagram showing domestic lead production in the United States, 1830–1911 ..... 318
6. Average weekly price of lead at New York and London in 1906 and 1907 ..... 346
7. Average weekly price of lead at New York and London in 1908 and 1909 ..... 347
8. Average weekly price of lead at New York and London in 1910 and 1911 ..... 348
9. Curves of spelter production and consumption, 1873–1911 ..... 357
10. Average weekly price of spelter and of 60 per cent zinc concentrates, and weekly production (sales) of zinc concentrates in the Joplin region in 1906 and 1907 ..... 390
11. Average weekly price of spelter and of 60 per cent zinc concentrates, and weekly production (sales) of zinc concentrates in the Joplin region in 1908 and 1909 ..... 391
12. Average weekly price of spelter and of 60 per cent zinc concentrates, and weekly production (sales) of zinc concentrates in the Joplin region in 1910 and 1911 ..... 392
13. Flow sheet of Leadville ore ..... 547
14. Flow sheet of Bingham ore ..... 767
15. Flow sheet of Park City ore ..... 772
16. Curve showing price of aluminum, by months, in 1911 ..... 935

# MINERAL RESOURCES OF THE UNITED STATES IN 1911—PART I.

## MINERAL PRODUCTS OF THE UNITED STATES: REVIEW OF CONDITIONS AND OUTPUT IN 1910 AND 1911.

By Edward W. Parker.

### CHARACTER AND SCOPE OF THE REPORT.

The arrangement and scope of the statistical data contained in this report are practically the same as in the twenty-seven preceding reports of the series Mineral Resources of the United States. Each report records the development of the mineral industries of the United States since the time covered by the preceding number of the series; the reports should therefore be consulted together. Each chapter is a census of the productive features of the industry under discussion. The statistics of the imports and exports of minerals, which form an essential part of the volume, are obtained through the courtesy of the Chief of the Bureau of Statistics, Department of Commerce and Labor.

During recent years the statistical treatment has been complemented by studies of the sources of the mineral production and the application of the products in the useful arts. The volumes have in this way grown into a cyclopedia of information, in fact as in name, on the mineral resources of the United States. An accurate knowledge of nature's storehouses from which future supplies are to be drawn is recognized as of paramount importance. To obtain this knowledge, as well as to record the history of past achievement, is the purpose and aim of the division of mineral resources.

### COOPERATION WITH STATE GEOLOGICAL SURVEYS.

In the preparation of the present report, as of those for 1908 and 1910, the United States Geological Survey has had the active cooperation of most of the State geological surveys. The statistics in such cases have been used jointly by the State and Federal surveys, and the results have been checked before publication. The objects attained by cooperative agreement are four in number:

1. The avoidance of annoyance to the producers in the form of duplicate requests for the same statistical information.
2. The securing of prompter and more complete returns.
3. The enabling of the State geologists to keep in touch with the producers and with new developments in their respective jurisdictions.
4. The avoidance of two divergent sets of statistics covering the same field and each bearing an official stamp, the existence of which is necessarily confusing to a student of the subject and tends to discredit one statement or the other, if not both.

Special acknowledgment is made of the assistance received by the United States Geological Survey from the directors of the State surveys; the cooperative arrangement has been carried out in a harmonious manner and with exceedingly gratifying results.

The officials who cooperated with the United States Geological Survey in 1911 are as follows:

Alabama.....Dr. Eugene A. Smith, State geologist, University.
Georgia.....Dr. S. W. McCallie, State geologist, Atlanta.
Illinois.....Mr. Frank W. De Wolf, director, Urbana.
Iowa.....Mr. George F. Kay, director, Iowa City.
Kansas.....Dr. Erasmus Haworth, State geologist, Lawrence.
Kentucky.....Mr. C. J. Norwood, director, Lexington.
Maryland.....Dr. Wm. B. Clark, State geologist, Baltimore.
Michigan.....Mr. R. C. Allen, director, Lansing.
Missouri.....Dr. H. A. Buehler, director, Rolla.
New Jersey.....Dr. Henry B. Kümmel, State geologist, Trenton.
North Carolina.....Dr. Joseph Hyde Pratt, State geologist, Chapel Hill.
Oklahoma.....Mr. D. W. Ohern, director, Norman.
Oregon.....Prof. H. M. Parks, director, Corvallis.
Pennsylvania.....Mr. Richard R. Hice, State geologist, Beaver.
Texas.....Dr. Wm. B. Phillips, director, Austin.
Virginia.....Dr. Thomas L. Watson, director, Charlottesville.
Washington.....Mr. Henry Landes, State geologist, Seattle.
Wisconsin.....Mr. W. O. Hotchkiss, State geologist, Madison.

## ORGANIZATION.

The division of mineral resources, under which this series of reports is compiled, has for the last few years been divided into two sections, namely, "metals" exclusive of iron and "nonmetals" including iron ores and pig iron. The section of metals has been under the administrative charge of Waldemar Lindgren and that of nonmetals under Frank B. Van Horn. For the purpose, primarily, of facilitating the work of collecting the statistics of the precious metals and of providing convenient places for consulting the publications of the United States Geological Survey by the mining fraternity of the Western States, offices of this division are maintained in Denver, Colo., Salt Lake City, Utah, and San Francisco, Cal. H. D. McCaskey has general supervision of the western offices. The division of mineral resources works in close cooperation with the division of economic geology, and most of the chapters and subchapters are prepared by geologists specialized in the subjects treated by them. The advantage of having the services of these specialists, familiar with the occurrence, treatment, and uses of the various mineral substances, is well recognized and has added materially to the standard of the reports. The contributions to the present report have been prepared by the following persons:

General:
Edward W. Parker—Review of conditions in 1910 and 1911.
William T. Thom—Summary of mineral production.
In the section of metals:
H. D. McCaskey—General report on gold and silver; gold, silver, copper, lead, and zinc in Eastern States (mine report); general supervision of reports on gold, silver, copper, lead, and zinc in Western States (mine report); metals and metallic ores—summary; quicksilver.
C. E. Siebenthal—General reports on lead, zinc, and cadmium.
B. S. Butler—General report on copper; special report on silver and copper in Michigan.
W. Lindgren—Platinum.
F. L. Hess—Tin; arsenic; antimony; bismuth; selenium; tungsten; vanadium; uranium; nickel; cobalt; titanium; tantalum.

J. P. Dunlop—Silver, copper, lead, and zinc in Central States (mine report); statistics of recovery of secondary metals, published as a press bulletin.
A. H. Brooks—Gold, silver, and copper in Alaska (mine report).
Chas. W. Henderson (in charge of Denver office)—Gold, silver, copper, lead, and zinc in Colorado, New Mexico, South Dakota, Wyoming, and Texas (mine report).
Chas. G. Yale (in charge of San Francisco office)—Gold, silver, copper, lead, and zinc in California and Oregon (mine report).
V. C. Heikes (in charge of Salt Lake City office)—Gold, silver, copper, lead, and zinc in Arizona, Utah, Nevada, and Montana (mine report).
C. N. Gerry—Gold, silver, copper, lead, and zinc in Idaho and Washington (mine report).

In the section of nonmetals:

Edward W. Parker—Coal; coke; briquetting of fuels.
David T. Day—Petroleum; asphalt, bituminous rock, and related bitumens.
David T. Day and B. Hill—Natural gas.
Charles A. Davis—Peat.
Ernest F. Burchard—Stone; iron ore and pig iron; cement; fluorspar and cryolite; gypsum; lime; manganese ore; sand and gravel.
Jefferson Middleton—Clay-working industries; sand-lime brick; feldspar and quartz; fuller's earth.
A. T. Coons—Slate.
J. S. Diller—Asbestos; talc and soapstone.
W. C. Phalen—Abrasive materials; salt and bromine; mineral paints; barytes and strontium; bauxite and aluminum; chromium; potash salts; sulphur and pyrite.
F. B. Van Horn—Phosphate rock.
Douglas B. Sterrett—Gems and precious stones; mica; monazite.
E. S. Bastin—Graphite.
Hoyt S. Gale—Borax; magnesite.
George C. Matson—Mineral waters.
R. B. Dole—Concentration of mineral waters in relation to their therapeutic effects.

Since 1907, when, at his own request, David T. Day was relieved as chief of division, the administration of the division of mineral resources has been under Edward W. Parker, statistician in charge.

## HISTORICAL REVIEW.

In the present report, as in the preceding ones of the series, the treatment of the mineral production is primarily by subjects. For detailed discussion of the occurrence and production by States of each mineral substance the reader should consult the chapters by subjects in the subsequent pages and in Part II of this report. The statistics of production include comparisons with earlier years, the figures for which are carried forward each year for convenient reference. The earlier volumes, beginning with that for 1882, the first of the series, should be consulted for other notes on occurrences, development, trade conditions and uses, descriptions of mining districts, and other information of a technical character which it is impracticable to carry forward from year to year.

In the 30 years covered by the Survey's annual reports on the mineral resources of the United States the value of the mineral production of this country has grown from $451,901,159 in 1882 to $1,918,326,253 in 1911. In 1880, according to the census of that year, the value of the mineral production was $364,928,298. The population of the United States in that year numbered 50,189,209 persons, so that the output of the mines represented an average of $7.27 for each inhabitant. The census of 1910 shows the population to have increased to 91,972,266 persons. The value of the mineral production in 1910 was $1,990,911,135, or an average of $21.65 for each inhabitant. In other words, the per capita mineral production

in 1910 as expressed in the value of the output was almost exactly three times what it was in 1880.

The most striking increases that have been made in the 30 years covered by this series of reports (from 1882 to 1911) have been in the production of iron, copper, and gold for the metals, and in the fuels (coal, petroleum, and natural gas) and cement for the nonmetals. The value of the pig-iron product has more than trebled, from $106,336,429 to $327,334,624. (In 1910 the pig-iron production was valued at $412,162,486, or nearly four times that of 1882.) The copper production in 1911, $137,154,092, was eight times that of 1882, $16,038,091, and the gold production was nearly three times, $96,890,000 in 1911 against $32,500,000 in 1882. The value of the silver production in 1911 was less than that of 1882 by $8,490,200, or 20.7 per cent, notwithstanding an increase of over 50 per cent in the quantity produced. This condition has been brought about by advances in metallurgy that have cheapened the cost of production. The price of silver in 1911 was less than half what it was in 1882. The combined value of the anthracite and bituminous coal production in 1911 was $626,366,876, or four and one-half times the $146,632,581 output of 1882; the value of the petroleum production was $24,065,988 in 1882 and $134,044,752 in 1911, the latter year being five and one-half times that of the earlier. Natural gas as a mineral product had just arrived in 1882, with a reported value of $215,000, and in 1911 the production was valued at $74,127,534. Next to natural gas the production of cement has shown the greatest percentage of increase, from $3,672,750 in 1882 to $66,248,817 in 1911.

Of the total value of the mineral output of the United States the metals constitute a little more than one-third and the nonmetals a little less than two-thirds. The largest quantity and the greatest value of all the mineral production are represented by the output of the coal mines. The production of coal in 1911 amounted to 496,221,168 short tons, valued at $626,366,876, the value being nearly one-third that of the total value of all the mineral products and equal to 93 per cent of the total metal production.

## RAW AND DERIVED PRODUCTS.

In compiling the statistics of mineral production the value of the metallic products is fixed upon the refined or partly refined metals, which is of course much greater than the value of the ores from which they are obtained. During recent years the statistics of pig-iron production have been supplemented by accurate determinations of the quantity of iron ore produced, with the value thereof, but the quantity and value of the pig iron have been maintained as the units of output. The ores of the precious and semiprecious metals are frequently complex mixtures of several metals, and no quantities or values can be expressed until the contents are extracted in metallic form and become articles of commerce. Chromic iron ore, manganese ore, manganiferous ores, and bauxite (aluminum ore) are marketed as such. In the nonmetals the quantities are expressed and the value placed upon the products in the condition in which they are first sold. With the fuels, with phosphate rock, and with some of the other nonmetals the quantities and values are for the raw product. With cement, however, there is no commercial product

until the material is in the finished state as cement. The clay products appear as finished brick, terra cotta, tile, porcelain, pottery, etc., with the exception of a small quantity of special clays sold raw. The quarry products are sold rough, partly dressed, and finished; salt appears in various refined conditions, as the content of brine, and as rock salt; gypsum is sold at first hands, as crude, as ground, and as calcined. There is no uniformity and there is no way of arriving at the quantities and values of the quarry products except in the condition as first marketed. The desirability of continuing to base the iron production on the output and value of pig iron may be open to some question, particularly since accurate records of the ore production and of the sources from which obtained are now available. In addition to putting a factitious value on the output, the distribution of the production by States gives undue prominence to those in which the blast furnaces are located and deprives the ore-producing States of proper credit. With pig iron the basis of values, the total value of the mineral production in the United States was $1,990,911,135 in 1910 and $1,918,326,253 in 1911, with Pennsylvania, Ohio, Illinois, and West Virginia as the four leading States. These four States are credited with one-half of the total value of the mineral output of the United States. California, with no standing as a producer either of pig iron or of iron ore, is fifth in rank, and Michigan and Minnesota, the leading producers of iron ore, appear as eleventh and thirty-eighth, respectively, in rank. With iron ores as the basis, the same four States remain at the head; but West Virginia, unimportant as a producer of iron ore or as a manufacturer of pig iron, outranked both Ohio and Illinois in 1910 and fell between those States in 1911; Michigan takes sixth place, following California and followed by Minnesota as seventh in rank; New York drops from sixth to thirteenth place, and Colorado from seventh to eighth in 1910 and tenth in 1911. In 1910 the four leading States, with iron ore as the basis, produced $713,081,926, or 41.5 per cent of the total which by the substitution is reduced to $1,719,484,256, and $719,382,360, or 42.9 per cent of the total of $1,677,411,459 for 1911.

In the following tables the States are arranged in the order of their rank as shown by the value of their mineral products in 1910 and 1911—first, with the valuation based on the production of pig iron, as has been customary in the preceding volumes of the series; second, with the iron ores taken as a basis of production:

*Rank of States in value of mineral production in 1910 and 1911.*

1910.

| Rank. | State. | Value, including pig iron and excluding iron ore. | State. | Value, including iron ore and excluding pig iron. |
|---|---|---|---|---|
| 1 | Pennsylvania | $585,402,329 | Pennsylvania | $411,827,343 |
| 2 | Ohio | 185,354,370 | West Virginia | 102,477,594 |
| 3 | Illinois | 140,237,550 | Ohio | 100,004,982 |
| 4 | West Virginia | 105,786,700 | Illinois | 98,772,007 |
| 5 | California | 86,723,743 | California | 86,721,069 |
| 6 | New York | 73,799,494 | Minnesota | 83,868,520 |
| 7 | Colorado | 60,661,422 | Michigan | 83,581,377 |
| 8 | Indiana | 57,784,240 | Colorado | 55,222,574 |
| 9 | Montana | 54,388,119 | Montana | 54,388,119 |
| 10 | Missouri | 52,703,156 | Missouri | 51,857,640 |
| 11 | Alabama | 48,124,174 | New York | 45,954,554 |

*Rank of States in value of mineral production in 1910 and 1911*—Continued.

1910—Continued.

| Rank. | State. | Value, including pig iron and excluding iron ore. | State. | Value, including iron ore and excluding pig iron. |
|---|---|---|---|---|
| 12 | Michigan | $47,306,866 | Indiana | $44,904,701 |
| 13 | Arizona | 43,483,912 | Arizona | 43,483,912 |
| 14 | Utah | 39,233,716 | Utah | 39,233,716 |
| 15 | Nevada | 34,617,127 | Nevada | 34,617,127 |
| 16 | Oklahoma | 32,988,865 | Oklahoma | 32,988,865 |
| 17 | New Jersey | 30,481,826 | Alabama | 30,080,280 |
| 18 | Kansas | 28,304,191 | Kansas | 28,304,191 |
| 19 | Iowa | 22,730,968 | New Jersey | 28,266,383 |
| 20 | Tennessee | 21,301,518 | Iowa | 22,730,968 |
| 21 | Kentucky | 21,132,698 | Kentucky | 19,883,476 |
| 22 | Texas | 18,370,251 | Texas | 18,404,254 |
| 23 | Virginia | 17,629,971 | Alaska | 17,191,688 |
| 24 | Alaska | 17,191,688 | Tennessee | 17,150,742 |
| 25 | Washington | 16,810,808 | Washington | 16,693,030 |
| 26 | Maryland | 15,440,207 | Idaho | 15,437,403 |
| 27 | Idaho | 15,437,403 | Virginia | 13,898,516 |
| 28 | Wisconsin | 13,860,531 | Wisconsin | 13,084,021 |
| 29 | Wyoming | 12,110,286 | Wyoming | 12,766,915 |
| 30 | Louisiana | 10,119,993 | Maryland | 10,238,488 |
| 31 | Florida | 9,284,705 | Louisiana | 10,119,993 |
| 32 | Vermont | 8,720,409 | Florida | 9,284,705 |
| 33 | New Mexico | 7,712,924 | Vermont | 8,720,409 |
| 34 | Minnesota | 6,365,239 | New Mexico | 7,902,036 |
| 35 | South Dakota | 6,095,814 | Georgia | 6,178,429 |
| 36 | Massachusetts | 6,040,736 | South Dakota | 6,095,814 |
| 37 | Georgia | 5,878,902 | Massachusetts | 5,903,976 |
| 38 | Arkansas | 5,373,105 | Arkansas | 5,373,105 |
| 39 | Maine | 4,713,123 | Maine | 4,713,123 |
| 40 | Oregon | 3,739,927 | Oregon | 3,739,927 |
| 41 | Connecticut | 3,448,977 | Connecticut | 3,284,895 |
| 42 | North Carolina | 2,616,581 | North Carolina | 2,730,818 |
| 43 | New Hampshire | 2,142,853 | New Hampshire | 2,142,853 |
| 44 | South Carolina | 2,021,371 | South Carolina | 2,021,371 |
| 45 | Nebraska | 1,552,794 | Nebraska | 1,552,794 |
| 46 | North Dakota | 860,233 | North Dakota | 860,233 |
| 47 | Mississippi | 840,152 | Mississippi | 840,152 |
| 48 | Rhode Island | 800,503 | Rhode Island | 800,503 |
| 49 | Delaware | 664,073 | Delaware | 664,073 |
| 50 | District of Columbia | 288,949 | District of Columbia | 288,949 |
| | Undistributed | 2,231,643 | Undistributed | 2,231,643 |
| | Total | 1,990,911,135 | Total | 1,719,484,256 |

1911.

| | | | | |
|---|---|---|---|---|
| 1 | Pennsylvania | $549,901,327 | Pennsylvania | $414,112,373 |
| 2 | Ohio | 170,544,327 | Illinois | 106,231,455 |
| 3 | Illinois | 137,384,382 | West Virginia | 101,948,248 |
| 4 | West Virginia | 105,958,493 | Ohio | 97,090,284 |
| 5 | California | 90,519,551 | California | 90,517,566 |
| 6 | New York | 63,357,365 | Michigan | 65,077,232 |
| 7 | Colorado | 57,170,961 | Minnesota | 53,460,561 |
| 8 | Missouri | 53,591,612 | Montana | 53,454,926 |
| 9 | Montana | 53,454,926 | Missouri | 52,636,348 |
| 10 | Indiana | 50,202,462 | Colorado | 51,958,239 |
| 11 | Michigan | 45,941,096 | Arizona | 44,104,731 |
| 12 | Arizona | 44,104,731 | Oklahoma | 42,678,446 |
| 13 | Oklahoma | 42,678,446 | New York | 42,392,180 |
| 14 | Utah | 41,139,075 | Utah | 41,139,075 |
| 15 | Alabama | 40,508,343 | Indiana | 37,430,187 |
| 16 | Nevada | 34,148,101 | Nevada | 34,148,101 |
| 17 | New Jersey | 26,984,275 | Alabama | 28,005,278 |
| 18 | Kansas | 24,987,807 | New Jersey | 27,559,246 |
| 19 | Iowa | 21,107,496 | Kansas | 24,987,807 |
| 20 | Tennessee | 20,709,756 | Iowa | 21,107,496 |
| 21 | Alaska | 20,072,420 | Alaska | 20,072,420 |
| 22 | Kentucky | 19,703,061 | Kentucky | 18,910,731 |
| 23 | Texas | 18,817,304 | Texas | 18,817,304 |
| 24 | Idaho | 17,588,340 | Tennessee | 17,902,451 |
| 25 | Virginia | 16,361,461 | Idaho | 17,588,340 |
| 26 | Washington | 15,853,556 | Washington | 15,853,556 |
| 27 | Wisconsin | 14,867,869 | Virginia | 13,609,364 |
| 28 | Maryland | 12,840,892 | Louisiana | 12,710,958 |
| 29 | Louisiana | 12,710,958 | Wisconsin | 12,451,436 |
| 30 | Wyoming | 11,007,060 | Wyoming | 11,486,982 |

*Rank of States in value of mineral production in 1910 and 1911*—Continued.

1911—Continued.

| Rank. | State. | Value, including pig iron and excluding iron ore. | State. | Value, including iron ore and excluding pig iron. |
|---|---|---|---|---|
| 31 | Florida | $10,250,228 | Florida | $10,250,228 |
| 32 | Vermont | 8,434,516 | Maryland | 9,386,663 |
| 33 | South Dakota | 8,037,372 | Vermont | 8,434,516 |
| 34 | New Mexico | 7,723,517 | South Dakota | 8,037,372 |
| 35 | Massachusetts | 6,700,386 | New Mexico | 7,869,918 |
| 36 | Georgia | 5,907,723 | Massachusetts | 6,623,077 |
| 37 | Arkansas | 5,829,606 | Georgia | 6,171,367 |
| 38 | Minnesota | 5,803,628 | Arkansas | 5,829,606 |
| 39 | Maine | 4,645,630 | Maine | 4,645,630 |
| 40 | Connecticut | 3,357,140 | Oregon | 3,198,796 |
| 41 | Oregon | 3,198,796 | Connecticut | 3,151,588 |
| 42 | North Carolina | 2,648,786 | North Carolina | 2,797,155 |
| 43 | South Carolina | 1,804,115 | South Carolina | 1,804,115 |
| 44 | New Hampshire | 1,727,645 | New Hampshire | 1,727,645 |
| 45 | Nebraska | 1,316,168 | Nebraska | 1,316,168 |
| 46 | Rhode Island | 1,088,475 | Rhode Island | 1,088,475 |
| 47 | Mississippi | 1,052,092 | Mississippi | 1,052,842 |
| 48 | North Dakota | 957,425 | North Dakota | 957,425 |
| 49 | Delaware | 491,657 | Delaware | 491,657 |
| 50 | District of Columbia | 277,295 | District of Columbia | 277,295 |
| | Undistributed | 2,856,600 | Undistributed | 2,856,600 |
| | Total | 1,918,326,253 | Total | 1,677,411,459 |

In the first instance, the total value of the mineral products was $1,990,911,135 in 1910, and $1,918,326,253 in 1911. In the second instance, the total value was $1,719,484,256 in 1910, and $1,677,411,459 in 1911. Over 65 per cent of the total mineral production is from the first 10 States, whose aggregate output was valued at $1,128,721,225 in 1910, and at $1,086,487,232 in 1911. Of these 10 leading States, 5—Pennsylvania, West Virginia, Ohio, Illinois, and Michigan—are east of Mississippi River; and 5—California, Minnesota, Colorado, Montana, and Missouri—are west of that boundary. The 5 eastern States produced minerals and mineral substances valued at $796,663,303 in 1910, and at $784,459,592 in 1911, nearly one-half the value of the total mineral production of the United States. The combined production of all the States east of the Mississippi (and these States aggregate only 28.8 per cent of the total area of the country, exclusive of Alaska) was $1,151,567,240, or 67 per cent of the total production of the United States in 1910, and $1,094,083,279, or 65 per cent of the total production in 1911. The States west of the Mississippi, whose areas aggregate 71.2 per cent of the total of the United States, had a combined mineral production valued at $565,685,373, or 33 per cent of the total, in 1910, and $580,471,580, or 35 per cent of the total, in 1911.

## LEADING STATES IN MINERAL PRODUCTION.

Forty-eight States and the Districts of Alaska and Columbia contribute to the mineral production of the United States. The output of the District of Columbia is principally from the clay beds in the form of common brick and drain tile.

Pennsylvania far outranks all other States in the value of its mineral output, having (exclusive of pig iron) contributed 24 per cent of the total in 1910, and 24.7 per cent in 1911. The reason for Pennsyl-

vania's undisputed leadership lies primarily in its great production of coal—it being almost exclusively the source of anthracite and the producer of over one-third of the total bituminous output. Pennsylvania ranks second, next to New York, in the value of its manufactures, and stands first as a mineral producer in the following products, namely: Cement, coal, coke, pig iron, lime, mineral paints, sand and gravel, and building stone, 8 in all. It is second in the production of clay manufactures, natural gas, and graphite; fourth in millstones; fifth in petroleum and sand-lime brick; ninth in iron ore and mineral waters.

The other States are leading producers as follows (the comparisons are based on values, not on quantity of output, though in most instances their relative ranks are identical):

*West Virginia.*—First in the production of natural gas; third in value, though second in quantity, in the production of both coal and coke; ninth in salt; tenth in clay products and pig iron.

*Ohio.*—First in clay products, grindstones, and pulp stones; second in pig iron, bromine, and lime; third in salt, natural gas, sand and gravel, gypsum, and oilstones; fourth in coal and stone; sixth in petroleum.

*Illinois.*—First in fluorspar; second in value, though third in quantity, in coal; second in infusorial earth; third in petroleum and pig iron; fourth in coke, in clay products, and in sand and gravel; fifth in cement, seventh in stone.

*California.*—First in petroleum, asphalt, borax, gems and precious stones, magnesite, platinum, and quicksilver; second in gold and tungsten ore; third in infusorial earth and pyrite; fourth in quantity and third in value of Portland cement.

*Michigan.*—First in sand-lime brick and bromine; second in iron ore, salt, and grindstones; third in copper; fourth in gypsum.

*Minnesota.*—First in iron ore; second in sand-lime brick; seventh in mineral waters.

*Colorado.*—First in gold, tungsten ore, and vanadium minerals; second in zinc; third in fluorspar; fourth in silver, lead, and mica.

*Missouri.*—First in lead, zinc, barytes, and infusorial earth; fourth in mineral paints; fifth in lime, and sand and gravel; sixth in cement.

*New York.*—First in salt, emery, abrasive garnet, graphite, gypsum, millstones, and talc; second in stone, mineral waters, sand and gravel, and pyrite; third in mineral paints, and sand-lime brick; fourth in iron ore, pig iron, feldspar, infusorial earth; fifth in clay products and slate; sixth in natural gas.

*Arizona.*—First in the production of copper.

*Nevada.*—First in silver; third in gold and quicksilver; fifth in copper; seventh in lead.

*Virginia.*—First in manganese ore and pyrite; second in millstones and soapstone; fourth in slate and barytes; fifth in coke; sixth in iron ore, mineral waters, and gypsum; seventh in pig iron.

*Wisconsin.*—First in mineral waters; third in lime; fourth in zinc and pyrite; fifth in iron ore and lead; sixth in mineral paints; ninth in stone.

*Louisiana.*—First in sulphur; sixth in salt; eighth in petroleum; ninth in natural gas.

*Florida.*—First in phosphate rock and fuller's earth; fourth in sand-lime brick.

*Vermont.*—First in asbestos; second in slate; third in stone and soapstone.

*Arkansas.*—First in bauxite and oilstones; third in fuller's earth.

*Maine.*—First in feldspar; third in slate; fourth in lime and mineral waters.

*North Carolina.*—First in mica, monazite, and zircon; second in barytes; third in millstones; fourth in talc and soapstone.

*Nebraska.*—First in the production of pumice.

*Indiana.*—Second in cement and oilstones; third in mineral waters; fifth in coal and stone; sixth in pig iron, coke, clay products, and sand-lime brick; seventh in natural gas, and sand and gravel.

*Utah.*—Second in vanadium minerals; third in silver, lead, and asphalt; fourth in copper; sixth in gold; seventh in zinc and precious stones; eighth in salt.

*Oklahoma.*—Second in petroleum; fifth in natural gas and asphalt; sixth in lead.

*Kansas.*—Second in pumice; third in cement; fourth in natural gas (third in quantity) and salt; sixth in zinc; seventh in gypsum.

*Iowa.*—Second in gypsum; eighth in clay products and sand-lime brick; ninth in coal.

*Kentucky.*—Second in fluorspar; fourth in asphalt; fifth in barytes; seventh in coal.

*Texas.*—Second in asphalt and quicksilver; fourth in fuller's earth; fifth in gypsum; seventh in salt and petroleum; ninth in silver; tenth in sand and gravel; eleventh in cement.

*Tennessee.*—Second in phosphate rock; third in barytes; fourth in bauxite; fifth in mineral paints; seventh in copper; eighth in iron ore and pig iron; eleventh in coal.

*Idaho.*—Second in lead; fourth in asbestos; fifth in silver; ninth in gold, copper, and zinc.

*Georgia.*—Second in asbestos, fuller's earth, bauxite, and mineral paints; fourth in barytes and graphite; fifth in pyrite.

*South Dakota.*—Second in mica; fifth in gold.

*Oregon.*—Second in platinum; ninth in sand and gravel; eleventh in gold.

*South Carolina.*—Second in monazite; third in phosphate rock; fifth in mica.

*Alabama.*—Third in iron ores, bauxite, and graphite; third in quantity and second in value in coke.

*New Jersey.*—Third in clay products and zinc; sixth in sand and gravel; seventh in iron ore and cement.

*Wyoming.*—Third in asbestos; tenth in coal.

*Connecticut.*—Third in the production of feldspar.

*New Hampshire.*—Third in the production of mica.

*Alaska.*—Fourth in the production of gold.

*Maryland.*—Fifth in feldspar and infusorial earth; sixth in slate; ninth in pig iron; twelfth in coke; thirteenth in coal.

*New Mexico.*—Fifth in precious stones; sixth in the production of mica; eighth in silver and zinc; ninth in lead.

*Massachusetts.*—Fifth in talc and soapstone; sixth in lime and fuller's earth; seventh in mica and pyrite; eighth in stone, mineral waters, and sand and gravel.

## INDIVIDUAL STATES.

### ALABAMA.

If pig iron is considered the basis of the iron production, Alabama ranks fifteenth among the States in value of mineral products. In the States south of Mason & Dixon's line and Ohio River, Alabama ranks second. If iron ores are taken as the basis Alabama takes seventeenth place among all the States, but maintains second place among the Southern States. The State is not the premier producer of any important mineral substance, but it ranks third in the production of iron ore; it ranks fourth in quantity and fifth in value of the pig iron produced; it is third in quantity and second in value of coke production; and it ranks sixth among the coal-producing States. It is third in the production of bauxite and graphite. Its production of gold and silver is negligible, and although some progress has been made in the development of its clay-working and quarrying industries these resources have not been exploited to the same extent as those of coal and iron.

The development of the mining industry began in 1882, the first year covered by this series of statistical reports, when attention was directed to the extensive iron deposits in the vicinity of Birmingham and contiguous to plentiful supplies of coking coal and limestone. The "boom" which followed was without precedent in the history of industrial development. The production of coal, which in 1881 was less than 350,000 tons, rose to nearly 2,500,000 tons in 1885. As in all cases of this kind speculation became wild and values were unreasonably inflated. The boom was succeeded by a relapse and two years of readjustment, and then followed a quarter century of steady and healthful growth. The maximum production of iron ore, of pig iron, of coal, and of coke was made in 1910, in which year the output of iron ore was 4,801,275 long tons, valued at $6,083,722; the pig iron production was 1,969,770 long tons, valued at $24,127,616; the production of coal was 16,111,462 short tons, valued at $20,236,853, and that of coke was 3,249,027 short tons, valued at $9,165,821. The depression in the iron trade of 1911 reduced the production of all four items. The output of iron ore fell off to 3,955,582 long tons, valued at $4,876,106; pig iron to 1,617,150 long tons, valued at $17,379,171; coal to 15,021,421 short tons, valued at $19,079,949; and coke to 2,761,521 short tons, valued at $7,593,594. The total value of the mineral production of Alabama, iron ore included and pig iron excluded, was $30 080,280 in 1910, decreasing to $28,005,278 in 1911. The decreases in Alabama were less in proportion, however, than those of other iron-producing States. The occurrence of the iron ore, coking coals, and limestone in close proximity in Alabama enables that State to produce iron at less cost than any other iron region in the world; wherefore in years of depression in the iron trade the reaction is felt less in Alabama than elsewhere, and the State proportion of the total production is augmented. The iron ores are principally non-Bessemer hematites. The chief steel production is open hearth. The principal coal-producing counties are Jefferson, Walker, Bibb, and Tuscaloosa, in the order named; the principal iron-ore counties are Jefferson, Tuscaloosa, Etowah, and Franklin. The iron-making industry is centered in Birmingham and vicinity.

In the following table is presented a comparison of the mineral output of Alabama in 1910 and 1911. The total values given at the bottom of the table include the value of the iron ore and of the coal made into coke, but do not include the value of pig iron or coke.

*Mineral production of Alabama in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Bauxite..long tons.. | (a) | (a) | | | (a) | (a) | | |
| Cement.....barrels.. | | | 406,214 | $387,600 | | | 593,911 | $529,359 |
| Clay products, short tons | 75,082 | b $38,045 | | 1,667,559 | 35,203 | b $29,909 | | 1,947,102 |
| Coal.....short tons.. | 16,111,462 | 20,236,853 | | | 15,021,421 | 19,079,949 | | |
| Coke.....do.... | | | 3,249,027 | b9,165,821 | | | 2,761,521 | b7,593,594 |
| Gold, fine ounces (troy) | | | 1,592 | 32,900 | | | 890 | 18,400 |
| Graphite, crystalline, pounds | (a) | (a) | | | (a) | (a) | | |
| Iron ore..long tons.. | 4,801,275 | 6,083,722 | | | 3,955,582 | 4,876,106 | | |
| Iron, pig.....do.... | | | 1,969,770 | b24,127,616 | | | 1,617,150 | b17,379,171 |
| Lime....short tons.. | | | 81,696 | 303,612 | | | 76,406 | 300,787 |
| Mica | | | | | | | | (a) |
| Millstones | | | | (c) | | | | (a) |
| Mineral waters, gallons sold | 133,159 | 30,639 | | | 205,854 | 26,982 | | |
| Natural gas | | (a) | | | | (a) | | |
| Sand and gravel, short tons | 619,253 | 187,591 | | | 677,894 | 215,413 | | |
| Silver, fine ounces (troy) | | | 300 | 200 | | | 200 | 100 |
| Stone | | (c) | | c1,054,568 | | (c) | | c923,998 |
| Miscellaneous | | 95,036 | | | | 78,652 | | 8,430 |
| Total value, eliminating duplications | | $30,080,280 | | | | $28,005,278 | | |

a Value included under "Miscellaneous."
b Not included in total value.
c Derived product includes stone sold rough in 1910 and 1911 and millstones in 1910.

## ALASKA.

According to Alfred H. Brooks, geologist in charge of the division of Alaskan mineral resources, mining in Alaska began in 1880, since which date the total value of the mineral production has amounted approximately to $207,000,000; over 90 per cent (or $195,619,776) of this is represented by the value of gold. In 1911 Alaska ranked fourth among the States and Territories as a gold producer. The gold amounted to 806,179 fine ounces, valued at $16,665,200, against 787,148 fine ounces, valued at $16,271,800 in 1910. Copper mining was actively pushed during 1911, and a total of 22,314,889 pounds, valued at $2,789,361, was obtained, against 4,311,026 pounds, valued at $547,500 in 1910. The silver production of Alaska is much less important than that of gold and copper, and amounted to $83,100 in 1910, and to $252,900 in 1911. The only other mineral products at the present time are graphite, gypsum, and marble, with small quantities of coal, lead, and tin.

The production of coal is approximately 1,000 tons annually. The development of the mining and other industries of Alaska is held

back by want of legislation which will permit the exploitation of the known extensive and valuable coal fields. The need of coal on the Pacific coast, which a few years ago would have been an inducement for the opening of the Alaskan coal fields, has now been supplied by the outflow of petroleum from wells in California. The only present demand for Alaskan coals would be for local consumption in the Territory, for the use of the Navy, and to supply coke to the smelters and foundries on Puget Sound, at Portland, San Francisco, Los Angeles, and other cities on the Pacific coast Most of the coke now consumed on the Pacific coast is imported from Germany or England or is brought from the Eastern States.

The following table gives the quantity and value of the mineral production of Alaska for 1910 and 1911:

*Mineral production of Alaska in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Coal.....short tons.. | 1,000 | $15,000 | ..... | ..... | 900 | $7,200 | ..... | ..... |
| Copper.....pounds. | ..... | ..... | 4,311,026 | $547,500 | ..... | ..... | 22,314,889 | $2,789,361 |
| Gold, fine ounces (troy) | ..... | ..... | 787,148 | 16,271,800 | ..... | ..... | 806,179 | 16,665,200 |
| Graphite, crystalline, pounds | (a) | (a) | ..... | ..... | ..... | ..... | ..... | ..... |
| Gypsum..short tons.. | (b) | ..... | ..... | (b) | (b) | ..... | ..... | (b) |
| Lead.....do.... | ..... | ..... | 60 | 5,280 | ..... | ..... | 50 | 4,500 |
| Silver, fine ounces (troy) | ..... | ..... | 153,900 | 83,100 | ..... | ..... | 468,300 | 252,900 |
| Stone | ..... | (a) | ..... | ..... | ..... | (a) | ..... | ..... |
| Tin (concentrates), short tons | ..... | ..... | 15 | 7,560 | ..... | ..... | 92 | 52,409 |
| Miscellaneous | ..... | (c) | ..... | c261,448 | ..... | (c) | ..... | c300,850 |
| Total value, eliminating duplications.. | $17,191,688 | | | | $20,072,420 | | | |

a Value included under "Miscellaneous."
b Calcined in Washington State. Value included under "Miscellaneous."
c Derived product includes raw product.

## ARIZONA.

The chief mining industry of Arizona is copper, in the production of which the new State ranks first. It ranks sixth in the production of silver and seventh in the production of gold. These three metals constitute 98 per cent of the total production of the State, which amounted to $43,483,912 in 1910 and $44,104,731 in 1911. The value of the copper product alone represents 86 per cent of the total output and the gold production about 8 per cent. The leading counties in the production of copper are Cochise, Greenlee, Yavapai, Gila, and Pima, and the counties furnishing the larger portion of the gold production are Mohave, Yavapai, Cochise, and Yuma. Siliceous ores furnish nearly two-thirds of the gold and nearly one-third is obtained in the reduction of copper ores. Smaller quantities are obtained from lead and zinc ores and from placers. Cochise and Yavapai counties are the principal producers of silver, most of which comes from copper ores.

The statistics of production in Arizona in 1910 and 1911 are shown in the following table:

*Mineral production of Arizona in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Cement.....barrels | ..... | ..... | (a) | (a) | ..... | ..... | ..... | ..... |
| Clay products, short tons | (a) (b) | (a) (b) | ..... | $126,777 | ..... | ..... | ..... | $106,882 |
| Copper.....pounds | ..... | ..... | 297,250,538 | 37,750,818 | ..... | ..... | 303,202,532 | 37,900,317 |
| Gems and precious stones | ..... | ..... | ..... | 32,510 | ..... | ..... | ..... | 17,643 |
| Gold, fine ounces (troy) | ..... | ..... | 165,114 | 3,413,200 | ..... | ..... | 170,348 | 3,521,400 |
| Gypsum..short tons | (a) | ..... | ..... | (a) | (a) | ..... | ..... | (a) |
| Lead.....do | ..... | ..... | 858 | 75,504 | ..... | ..... | 3,450 | 310,500 |
| Lime.....do | ..... | ..... | 13,728 | 68,055 | ..... | ..... | 13,844 | 69,940 |
| Quartz.....do | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Sand and gravel, short tons | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Silver, fine ounces, (troy) | ..... | ..... | 2,655,700 | 1,434,100 | ..... | ..... | 3,228,900 | 1,743,600 |
| Stone | ..... | (c) | ..... | c 163,696 | ..... | (c) | ..... | c 55,714 |
| Sulphuric acid (60° Baumé)[b], short tons | ..... | ..... | ..... | (d) | ..... | ..... | (d) | (d) |
| Tungsten ore (60 per cent concentrates), short tons | ..... | ..... | (a) | (a) | ..... | ..... | 50 | 16,559 |
| Zinc.....short tons | ..... | ..... | 2,594 | 280,152 | ..... | ..... | 2,476 | 282,264 |
| Miscellaneous | ..... | $48,520 | ..... | 93,795 | ..... | $13,765 | ..... | 66,147 |
| Total value, eliminating duplications | $43,483,912 | | | | $44,104,731 | | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product includes stone sold rough.
d From copper smelters. No report for 1910. Value included under "Miscellaneous."

## ARKANSAS.

Arkansas ranks thirty-eighth among the States in the value of its mineral production. The principal product is coal, which constitutes over 50 per cent of the total value. Arkansas is the premier State in the production of two minerals—bauxite and novaculite, the former being the ore of aluminum, the latter the source of the larger part of the oilstones produced in the United States. It ranks third among the States in the production of fuller's earth. Next to coal the greatest value of the mineral production of Arkansas is represented by the clay-working industries, and bauxite mining is third in importance. Coal is mined in 7 counties, of which Sebastian is by far the most important with over 70 per cent of the total output. Franklin County is second in importance, and Johnson third. The coals of Arkansas are generally high grade, and some approach anthracite in quality. The semianthracite of Arkansas is much prized as a domestic fuel, reaching markets as far north as Kansas City. Owing, however, to the high cost of labor, to the unfavorable mining conditions, and to the competition with petroleum and natural gas and with coals from other States, the coal-mining industry has been practically at a

standstill for the last 10 years. The production in 1910 was less than in 1902, and that of 1911 was less than in 1903 and than the average of the 10 years ending with 1911.

The statistics of the mineral production of Arkansas in 1910 and 1911 are shown in the following table:

*Mineral production of Arkansas in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Bauxite...long tons.. | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Clay products..... | ..... | ..... | ..... | $578,455 | ..... | ..... | ..... | $480,643 |
| Coal.....short tons.. | 1,905,958 | $2,979,213 | ..... | ..... | 2,106,789 | $3,396,849 | ..... | ..... |
| Fuller's earth..do.... | 2,563 | 29,137 | ..... | ..... | (a) | (a) | ..... | ..... |
| Gems and precious stones..... | ..... | ..... | ..... | 1,200 | ..... | ..... | ..... | 2,700 |
| Lead....short tons.. | ..... | ..... | ..... | ..... | ..... | ..... | 15 | 1,350 |
| Lime.....do.... | ..... | ..... | 26,532 | 127,068 | ..... | ..... | 22,847 | 109,067 |
| Manganese ore and manganiferous ore, long tons..... | 5,530 | 14,700 | ..... | ..... | b 2,177 | b 5,354 | ..... | ..... |
| Mineral waters, gallons sold..... | 1,065,676 | 89,772 | ..... | ..... | 1,560,157 | 118,994 | ..... | ..... |
| Natural gas..... | ..... | (a) | ..... | ..... | ..... | (a) | ..... | ..... |
| Oil stones..... | ..... | ..... | ..... | (c) | ..... | ..... | ..... | (a) |
| Phosphate rock, long tons..... | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Sand and gravel, short tons..... | 1,061,037 | 230,680 | ..... | ..... | 1,007,589 | 183,897 | ..... | ..... |
| Slate..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | (a) |
| Stone..... | ..... | 81,015 | ..... | 301,596 | ..... | (d) | ..... | d 526,352 |
| Zinc.....short tons.. | ..... | ..... | 286 | 30,888 | ..... | ..... | 385 | 43,890 |
| Miscellaneous..... | ..... | c 909,381 | ..... | ..... | ..... | 864,043 | ..... | 96,467 |
| Total value, eliminating duplications.. | $5,373,105 | | | | $5,829,606 | | | |

a Value included under "Miscellaneous."
b Manganiferous ore only.
c "Miscellaneous" raw products include oilstones.
d Derived product includes stone sold rough.

## CALIFORNIA.

Whether pig iron or iron ore is taken as a basis of mineral production, California ranks fifth among the States in the value of its output. It is first among the States west of Mississippi River. In former years California rested its claim to distinction as a mineral producer on its output of gold, in which it held first place in 1911, though in recent years it has usually fallen behind Colorado in the production of gold. The premiership of gold in the State has been succeeded by petroleum, the value of which in California exceeds that of gold by 94 per cent, and gives the State first place among the States in the production of crude oil. California leads also in the production of asphalt, of platinum, and of quicksilver, and enjoys a monopoly in the production of borax and magnesite. It is second in the production of tungsten ores, being exceeded by Colorado; it ranks third in the production of cement, sixth in the production of copper, and stands well up among the States in the production of a number of less important minerals. The values of the more important products in the last two years have been as follows: Petroleum, $35,749,473 in

1910 and $38,719,080 in 1911; gold, $20,441,400 in 1910 and $19,928,500 in 1911; cement, $7,355,301 in 1910 and $8,737,150 in 1911; copper, $5,811,545 in 1910 and $4,479,456 in 1911; clay products, $4,842,391 in 1910 and $4,915,866 in 1911; stone, $4,245,892 in 1910 and $4,676,902 in 1911; asphalt, $1,338,736 in 1910 and $2,104,121 in 1911; borax, $1,201,842 in 1910 and $1,569,151 in 1911. The principal petroleum-producing counties are, Kern (producing over half of the total for the State), Fresno, Santa Barbara, Los Angeles, and Orange, in the order of their importance. Seven counties produce gold in excess of $1,000,000 in value yearly, namely and in order: Yuba, Amador, Nevada, Butte, Shasta, Sacramento, and Calaveras. Of the total gold production of California about 55 per cent is from deep mines and 45 per cent from placers. Nearly 90 per cent of the placer gold is the output of the dredges. Of the deep mine product 94 per cent is from siliceous ores, the other 6 per cent being obtained from copper and lead ores. The production of copper comes chiefly from Shasta County (over 80 per cent of the total) with Calaveras second (about 15 per cent of the total).

The total value of the mineral production of California in 1911 was $90,517,566, against $86,721,069 in 1910. The details by substances are shown in the following table:

*Mineral production of California in 1910 and 1911.*

| Product. | 1910. | | | | 1911. | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Asphalt..short tons.. | 38,799 | $140,954 | 104,687 | $1,197,782 | 36,081 | $215,230 | 154,864 | $1,889,191 |
| Briquets, fuel..do.... | | | | (a) | | | (b) (c) | (b) (c) |
| Borax.....do.... | 42,357 | 1,201,842 | | | 53,330 | 1,569,151 | | |
| Cement.....barrels.. | | | (c) | (c) | | | 6,317,701 | 8,737,150 |
| Chromite..long tons.. | 205 | 2,729 | | | 120 | 1,629 | | |
| Clay products, short tons..... | 70,465 | b 104,163 | | 4,842,391 | 87,256 | b 112,316 | | 4,915,866 |
| Coal.....short tons.. | 11,164 | 18,336 | | | 10,747 | 16,097 | | |
| Copper.....pounds.. | | | 45,760,200 | 5,811,545 | | | 35,835,651 | 4,479,456 |
| Feldspar.short tons.. | (c) | (c) | | | (c) | (c) | | |
| Fuller's earth..do.... | (c) | (c) | | | (c) | (c) | | |
| Gems and precious stones..... | | | | 104,648 | | | | 28,370 |
| Gold, fine ounces (troy)..... | | | 988,853 | 20,441,400 | | | 964,041 | 19,928,500 |
| Gypsum, short tons.. | 45,901 | | | 242,203 | 43,855 | | | 204,264 |
| Infusorial earth..... | | | | (c) | | | | (c) |
| Iron ore...long tons.. | (c) | (c) | | | (c) | (c) | | |
| Iron, pig.....do.... | | | (b) (c) | (b) (c) | | | (b) (c) | (b) (c) |
| Lead.....short tons.. | | | 1,160 | 102,080 | | | 615 | 55,350 |
| Lime.....do.... | | | 63,759 | 613,242 | | | 72,858 | 564,175 |
| Magnesite.....do.... | 12,443 | 74,658 | | | 9,375 | 75,000 | | |
| Manganese ore, long tons..... | | | | | (c) | (c) | | |
| Mineral paints, natural pigments, short tons..... | | | 2,116 | 36,470 | | | (c) | (c) |
| Mineral waters, gallons sold..... | 2,008,697 | 394,841 | | | 2,310,237 | 578,439 | | |
| Natural gas..... | | 476,697 | | | | 800,714 | | |
| Petroleum...barrels.. | 73,010,560 | 35,749,473 | | | 81,134,391 | 38,719,080 | | |
| Platinum,fine ounces (troy)..... | | | 337 | 8,386 | | | 511 | 14,873 |
| Pyrite....long tons.. | 27,158 | 129,504 | | | 48,415 | 182,787 | | |
| Quicksilver...flasks.. | | | 17,211 | 800,484 | | | 18,860 | 867,749 |

a No report for 1910.
b Value not included in total value.
c Value included under "Miscellaneous."

*Mineral production of California in 1910 and 1911*—Continued.

| Product. | 1910. | | | | 1911. | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Salt.....barrels.. | 78,571 | 39,000 | 858,943 | 480,667 | 23,350 | 11,442 | 1,062,813 | 543,917 |
| Sand and gravel, short tons..... | 2,065,297 | 440,950 | ..... | ..... | 1,911,652 | 416,980 | ..... | ..... |
| Sand-lime brick..... | ..... | ..... | ..... | 43,512 | ..... | ..... | ..... | 19,535 |
| Silver, fine ounces (troy)..... | ..... | ..... | 1,791,600 | 967,500 | ..... | ..... | 1,270,900 | 686,300 |
| Slate..... | ..... | ..... | ..... | (a) | ..... | ..... | ..... | ..... |
| Stone..... | ..... | (a) | ..... | (a) | ..... | (b) | ..... | b4,676,902 |
| Sulphuric acid (60° Baumé),d short tons..... | ..... | ..... | ..... | (c) | ..... | ..... | (d) | (d) |
| Talc.....short tons.. | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Tungsten ore (60 per cent concentrates), short tons..... | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Zinc.....short tons.. | ..... | ..... | ..... | ..... | ..... | ..... | 959 | 109,326 |
| Miscellaneous..... | ..... | 8,511 | ..... | 12,354,464 | ..... | 4,915 | ..... | 312,525 |
| Total value, eliminating duplications.... | $86,721,069 | | | | $90,517,566 | | | |

a Value included under "Miscellaneous."
b Derived product includes stone sold rough.
c No report for 1910.
d From copper smelters. Value included under "Miscellaneous."

## COLORADO.

Colorado was the first State in the production of gold in 1910, having a lead over California of less than $100,000. In 1911 production fell off in both States, and as the decrease in Colorado was more than in California, the latter State became again, as it had been in earlier years, the principal source of the yellow metal. Colorado ranks tenth among all the States in the total value of its mineral production, and is fifth among the States west of Mississippi River. Gold is the principal mineral product of the State, with coal a good second. The gold output was valued at $20,526,500 in 1910 and at $19,138,800 in 1911. The production of coal decreased from 11,973,736 short tons, valued at $17,026,934, in 1910 to 10,157,383 tons, valued at $14,747,764, in 1911. As a producer of coal Colorado ranks first among the Western States. It is also the leading Western State in the manufacture of pig iron and of coke. Pig iron is third in value among the products of the State, followed in order by zinc, silver, coke, lead, clay products, stone, and copper. Colorado is the leading State in the production of tungsten ores and vanadium minerals, second in the production of gold and zinc, third in the production of fluorspar, fourth in lead, silver, and mica.

Teller County produces more than one-half the total gold output of the State, all from deep mines and all from siliceous ores unmixed with other metals. The other important gold-producing counties are San Miguel, Ouray, Lake, San Juan, Gilpin, and Clear Creek. Ninety-five per cent of the total output of gold in the State is from siliceous ores. In the production of coal Las Animas County bears nearly the same relation to the total output that Teller County does for gold,

almost one-half of the total coal production coming from Las Animas County. Huerfano County is second in production of coal, with 20 per cent of the total, Boulder, Fremont, and Gunnison following in the order named.

As shown in the following table the total value of the mineral production of Colorado decreased from $55,222,574, in 1910, to $51,958,239 in 1911:

*Mineral production of Colorado in 1910 and 1911.*

| Product. | 1910. | | | | 1911. | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Bismuth..short tons.. | ..... | ..... | (a) | (a) | ..... | ..... | ..... | ..... |
| Cement.....barrels.. | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Clay products, short tons..... | 105,874 | b $83,855 | ..... | $2,033,714 | 95,127 | b $83,636 | ..... | $1,606,709 |
| Coal.....short tons.. | 11,973,736 | 17,026,934 | ..... | ..... | 10,157,383 | 14,747,764 | ..... | ..... |
| Coke.....do.... | ..... | ..... | (a) (b) | (a) (b) | ..... | ..... | (a) (b) | (a) (b) |
| Copper.....pounds.. | ..... | ..... | 9,307,497 | 1,182,052 | ..... | ..... | 9,791,861 | 1,223,983 |
| Fluorspar..short tons . | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Fuller's earth..do.... | (a) | (a) | ..... | ..... | ..... | ..... | ..... | ..... |
| Gems and precious stones..... | ..... | ..... | ..... | 9,280 | ..... | ..... | ..... | 2,520 |
| Gold, fine ounces (troy)..... | ..... | ..... | 992,969 | 20,526,500 | ..... | ..... | 925,839 | 19,138,800 |
| Graphite, amorphous, short tons..... | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Grindstones..... | ..... | ..... | ..... | (a) | ..... | ..... | ..... | (a) |
| Gypsum..short tons.. | 45,820 | ..... | ..... | 119,259 | 26,226 | ..... | ..... | 67,199 |
| Iron ore...long tons.. | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Iron, pig.....do.... | ..... | ..... | (a) (b) | (a) (b) | ..... | ..... | (a) (b) | (a) (b) |
| Lead.....short tons.. | ..... | ..... | 35,685 | 3,140,280 | ..... | ..... | 30,621 | 2,755,890 |
| Lime.....do.... | ..... | ..... | 8,057 | 40,860 | ..... | ..... | 6,403 | 34,614 |
| Manganiferous ore, long tons..... | 55,770 | 176,448 | ..... | ..... | 41,753 | 109,340 | ..... | ..... |
| Mica..... | ..... | ..... | ..... | (a) | ..... | ..... | ..... | (a) |
| Mineral waters, gallons sold..... | 1,638,984 | 115,289 | ..... | ..... | 1,436,066 | 104,763 | ..... | ..... |
| Natural gas..... | ..... | (a) | ..... | ..... | ..... | (a) | ..... | ..... |
| Petroleum...barrels.. | 239,794 | 243,402 | ..... | ..... | 226,926 | 228,104 | ..... | ..... |
| Sand and gravel, short tons..... | 1,197,751 | 154,039 | ..... | ..... | 247,666 | 65,366 | ..... | ..... |
| Sand-lime brick..... | ..... | ..... | ..... | (a) | ..... | ..... | ..... | (a) |
| Silver, fine ounces (troy)..... | ..... | ..... | 8,523,000 | 4,602,400 | ..... | ..... | 7,331,200 | 3,958,800 |
| Stone..... | ..... | (c) | ..... | c1,177,785 | ..... | (c) | ..... | c1,514,827 |
| Sulphuric acid (60° Baumé), e short tons..... | ..... | ..... | ..... | (e) | ..... | ..... | (e) | (e) |
| Tungsten ore (60 per cent concentrates), short tons..... | ..... | ..... | 1,221 | 535,567 | ..... | ..... | 730 | 234,513 |
| Uranium and vanadium ores, short tons..... | ..... | ..... | (a) (d) | (a) (d) | ..... | ..... | 8,400 | 302,000 |
| Zinc.....short tons.. | ..... | ..... | 23,238 | 2,509,704 | ..... | ..... | 42,233 | 4,814,562 |
| Miscellaneous..... | ..... | 72,355 | ..... | 10,700,037 | ..... | 77,133 | ..... | 9,112,517 |
| Total value, eliminating duplications. | $55,222,574 | | | | $51,958,239 | | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product includes stone sold rough.
d Vanadium only.
e From zinc smelters. No report for 1910. Value included under "Miscellaneous."

## CONNECTICUT.

The principal mineral products of Connecticut are from the quarries and clay pits. A small quantity of iron ore is mined and a small quantity of pig iron is made in the State, but aside from this there is no metal mining of any sort, nor any production of mineral fuel. The quarrying industry yielded stone products valued at $1,057,874 in 1910, and at $1,215,462 in 1911. The principal stones quarried are granite and trap rock. The principal granite operations are in New Haven and New London counties, and trap rock is produced in Hartford and New Haven counties. The clay products were valued at $1,478,936 in 1910, and at $1,284,166 in 1911. Lime to the value of $417,850 was produced in 1910 and to the value of $328,904 in 1911. The lime-producing counties are Fairfield and Litchfield, in the extreme western part of the State.

Connecticut is the third State in the Union in the production of feldspar, with an output valued at $89,974 in 1910 and at $73,557 in 1911. Its other commercial mineral products are infusorial earth, mineral waters, quartz, sand-lime brick, sand and gravel. The total value of the mineral products, as shown in the following table, was $3,284,895 in 1910 and $3,151,588 in 1911.

*Mineral production of Connecticut in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products, short tons | [a] [b] | [a] [b] | | $1,478,936 | | | | $1,284,166 |
| Feldspar, short tons | 18,739 | $89,974 | | | 16,497 | $73,557 | | |
| Infusorial earth | | | | [b] | | | | [b] |
| Iron ore, long tons | [b] | [b] | | | [b] | [b] | | |
| Iron, pig, do | | | [a] [b] | [a] [b] | | | [a] [b] | [a] [b] |
| Lime, short tons | | | 93,576 | 417,850 | | | 69,719 | 328,904 |
| Mineral waters, gallons sold | 1,608,775 | 109,853 | | | 2,164,701 | 182,744 | | |
| Quartz, short tons | [b] | [b] | | | [b] | [b] | | |
| Sand and gravel, short tons | 16,676 | 12,775 | | | 20,270 | 10,559 | | |
| Sand-lime brick | | | | | | | | [b] |
| Stone | | [c] | | [c]1,057,874 | | [c] | | [c]1,215,462 |
| Miscellaneous | | 117,458 | | 251,920 | | 55,436 | | 243,880 |
| Total value, eliminating duplications | $3,284,895 | | | | $3,151,588 | | | |

[a] Value not included in total value.
[b] Value included under "Miscellaneous."
[c] Derived product includes stone sold rough.

## DELAWARE.

Delaware is limited in its mineral production to its quarries and to its clay, sand, and gravel pits. All of these are of small importance when compared with those of other States. The total production of the State in 1911 was valued at $491,657, of which $218,234 was represented by the output of the stone quarries and $200,610 by the clay products. In 1910 the total production was valued at

$664,073, of which $357,708 was furnished by the quarries and $216,555 by the clay works.

The statistics of mineral production in Delaware in 1910 and 1911 are given in the following table:

*Mineral production of Delaware in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products, short tons | 11,117 | a$60,744 | ..... | $216,555 | 7,950 | a$46,024 | ..... | $200,610 |
| Mineral waters, gallons sold | (b) | (b) | ..... | ..... | (b) | (b) | ..... | ..... |
| Sand and gravel, short tons | 164,056 | 66,869 | ..... | ..... | 137,205 | 65,813 | ..... | ..... |
| Sand-lime brick | ..... | ..... | ..... | (b) | ..... | ..... | ..... | ..... |
| Stone | ..... | 243,896 | ..... | 113,812 | ..... | (c) | ..... | c218,234 |
| Miscellaneous | ..... | (c) | ..... | c22,941 | ..... | 7,000 | ..... | ..... |
| Total value, eliminating duplications | | $664,073 | | | | $491,657 | | |

a Value not included in total value.
b Value included under "Miscellaneous."
c Derived product includes raw product.

## DISTRICT OF COLUMBIA.

The mineral production in the District of Columbia is principally the output of the clay beds in the vicinity of Washington. The main products from these are common building brick, terra cotta, and drain tile. A small quantity of stone is quarried for use in concrete for foundations and for road making. One plant for making sand-lime brick is established in the District, and the waters from two springs are sold commercially.

The statistics of mineral production in the District of Columbia in 1910 and 1911 are shown in the following table:

*Mineral production of the District of Columbia in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products | ..... | ..... | ..... | a$242,861 | ..... | ..... | ..... | a$227,520 |
| Mineral waters, gallons sold | (b) | (b) | ..... | ..... | (b) | (b) | ..... | ..... |
| Sand-lime brick | ..... | ..... | ..... | (b) | ..... | ..... | ..... | (b) |
| Stone | ..... | ..... | ..... | ..... | ..... | (b) | ..... | ..... |
| Miscellaneous | ..... | (c) | ..... | c46,088 | ..... | (c) | ..... | c49,775 |
| Total value, eliminating duplications | | $288,949 | | | | $297,295 | | |

a Exclusive of pottery, which is included under "Miscellaneous."
b Value included under "Miscellaneous."
c Derived product includes raw product.

## FLORIDA.

The mining industry of Florida may be said to have had its beginning in the discovery of the phosphate beds in 1888 and 1889. Public attention has been called to the possibilities of what has since grown to an important industry, in Mineral Resources for 1884, about five years before. The first ten years following the discovery of commercial deposits were notable principally as an area of promotion of the speculative type, of inflated values, and of over production, with the usual collapse and readjustment. The boom in Florida phosphate lands and the aftermath were somewhat akin to the iron boom of Birmingham, Ala., about 10 years earlier. After the collapse values were readjusted; development since has proceeded along natural and conservative lines, and the production of Florida phosphate is an established and prosperous industry. Four kinds of phosphate are produced—hard rock, soft rock, land pebble, and river pebble, the first mentioned being generally the highest grade and the only one for which there is demand for export.

Florida is the leading State in the production of phosphate rock, which constitutes 95 per cent of the States' mineral production. In 1910 the total value of the mineral output of Florida was $9,284,705, of which $8,647,774 was the value of the phosphate rock produced. In 1911 the phosphate product was valued at $9,473,638, and the total value of all mineral products was $10,250,228. The leading counties in the production of phosphate rock are Polk, Citrus, Alachua, and Marion.

Florida is also the premier State in the production of fuller's earth, a variety of clay used principally for filtering and clarifying animal, mineral, and vegetable oils, and in 1911 it lead in the production of ball clay. It is fourth in the production of sand-lime brick. Other products are clay and its manufactures, lime, mineral waters, sand, and gravel. The following table gives the production of minerals in Florida in 1910 and 1911:

*Mineral production of Florida in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products, short tons | 27,403 | [a]$134,542 | ..... | $237,268 | 24,167 | [a]$114,751 | ..... | $217,535 |
| Fuller's earth, short tons | 18,832 | 170,267 | ..... | ..... | 27,658 | 265,571 | ..... | ..... |
| Lime.....short tons | ..... | ..... | 10,482 | 58,386 | ..... | ..... | 10,867 | 49,221 |
| Mineral waters, gallons sold | 90,189 | 14,269 | ..... | ..... | 114,416 | 19,330 | ..... | ..... |
| Phosphate rock, long tons | 2,067,507 | 8,647,774 | ..... | ..... | 2,436,248 | 9,473,638 | ..... | ..... |
| Sand and gravel, short tons | 34,858 | 21,912 | ..... | ..... | 112,776 | 33,339 | ..... | ..... |
| Sand-lime brick | ..... | ..... | ..... | 85,450 | ..... | ..... | ..... | 56,274 |
| Stone | ..... | (b) | ..... | (c) | ..... | ..... | ..... | (c) |
| Miscellaneous | ..... | (b) | ..... | [b] 49,379 | ..... | ..... | ..... | 135,320 |
| Total value, eliminating duplications | $9,284,705 | | | | $10,250,228 | | | |

[a] Value not included in total value.
[b] Derived product includes stone sold rough.
[c] Value included under "Miscellaneous."

## GEORGIA.

Although Georgia ranks second among all the States in the production of four mineral substances, namely, asbestos, bauxite, mineral paints, and fuller's earth, the principal values are from the outputs of the stone quarries and the clay-working industry. In the value of building stone produced, Georgia ranks first among the Southern States, and third in the value of clay products, being exceeded only by West Virginia and Texas. Georgia granites have a high reputation for building, and Georgia marbles are highly prized for structural and decorative use. The clay products are principally building brick and sewer pipe. In the production of a peculiar quality of clay used by paper makers Georgia ranks first, with a production in 1911 valued at approximately $200,000 in its raw state. In 1911 in a total value in mineral products of $6,171,367, the clay-working industries are represented by $2,859,842 and the quarrying industries by $1,967,077. In 1910 the clay-working industries produced wares to the value of $2,755,823, the quarry products were valued at $2,027,339, and the total production was valued at $6,178,429. The principal stone-producing counties are De Kalb and Elbert for granite, and Pickens for marble. The clay-working industry is most highly developed in Bibb, Fulton, Richmond, Muscogee, and Walker counties. Georgia is one of the chief sources of supply of ocher, umber, and sienna, and is fourth in the production of graphite. Two counties, Dade and Walker, in the northwest corner of the State produce high-grade bituminous coal. Bauxite, cement, coke, fuller's earth, iron ore, mineral waters, and sand and gravel are products of considerable importance, and those of minor consequence are asbestos, barytes, copper, gold, gypsum, lime, pyrite, sand-lime brick, silver, slate, and soapstone.

The statistics of the mineral production of Georgia in 1910 and 1911 are shown in the following table:

*Mineral production of Georgia in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Asbestos .short tons | (a) | (a) | | | (a) | (a) | | |
| Barytes.....do | (a) | (a) | | | (a) | (a) | | |
| Bauxite...long tons | (a) | (a) | | | (a) | (a) | | |
| Cement.....barrels | | | 383,262 | $279,535 | | | 368,462 | $330,186 |
| Clay products, short tons | 66,292 | b$223,785 | | 2,532,038 | 68,161 | b$223,462 | | 2,636,380 |
| Coal.....short tons | 177,245 | 259,122 | | | 165,210 | 246,208 | | |
| Coke.....do | | | 43,814 | b 173,049 | | | 37,553 | b 135,190 |
| Copper.....pounds | | | 724 | 92 | | | | |
| Fuller's earth, short tons | (a) | (a) | | | (a) | (a) | | |
| Gold, fine ounces (troy) | | | 1,161 | 24,000 | | | 1,548 | 32,000 |
| Gypsum .short tons | | | | | | | | (c) |
| Iron ore...long tons | 313,878 | 482,659 | | | 207,279 | 315,704 | | |
| Iron, pig.....do | | | b 8,325 | b 183,132 | | | b 3,519 | b 52,060 |
| Lime.....short tons | | | 7,621 | 29,961 | | | 6,282 | 24,067 |

a Value included under "Miscellaneous."
b Value not included in total value.
c Not mined, but calcined, in Georgia. Value included under "Miscellaneous."

*Mineral production of Georgia in 1910 and 1911*—Continued.

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Mineral paints, natural pigments, short tons | | | 7,564 | 71,240 | | | 8,515 | 71,197 |
| Mineral waters, gallons sold | 734,135 | 63,171 | | | 981,080 | 97,752 | | |
| Pyrite....long tons | (a) | (a) | | | (a) | (a) | | |
| Sand and gravel, short tons | 352,379 | 123,143 | | | 518,885 | 175,734 | | |
| Sand-lime brick | | | | (a) | | | | (a) |
| Silver, fine ounces (troy) | | | 300 | 200 | | | 600 | 300 |
| Slate | | | | (a) | | | | (a) |
| Stone | | 1,069,076 | | 958,263 | | (b) | | b 1,967,077 |
| Talc and soapstone, short tons | (b) | (b) | (a) | (a) | | | (a) | (a) |
| Miscellaneous | | 235,009 | | 50,920 | | 226,878 | | 47,884 |
| Total value, eliminating duplications | | $6,178,429 | | | | $6,171,367 | | |

a Value included under "Miscellaneous." b Derived product includes raw product.

## IDAHO.

The principal mineral products of Idaho are lead and silver, the output chiefly of the Cœur d'Alene mining district in Shoshone County. Gold, copper, and zinc are produced in small quantities. Shoshone County produces 92 per cent of the ores of precious and semiprecious metals mined in the State. Of refined lead, the chief source of mineral wealth in the State, Shoshone County produces 96 per cent; of silver it produces 92 per cent; of copper 85 per cent; and of zinc nearly 99 per cent. The total value of the metal production of Idaho, as reported by the mining companies, was $16,316,196 in 1910 and $19,100,894 in 1911, of which Shoshone County is credited with $14,416,910 in 1910 and $16,306,680 in 1911. The production of metals in Idaho as reported from the smelters, which does not make any distribution by counties, differs considerably from that reported from the mines. In 1910 the total value of the metal production in Idaho as reported by the smelters was $14,870,288; in 1911 it was $17,248,795. The total mineral production of the State, using smelter figures for the metal production, was $15,437,403 in 1910 and $17,588,340 in 1911, of which the metal production represented 96 per cent and the production of Shoshone County alone 84 per cent.

The nonmetal products, of which Idaho furnishes relatively unimportant quantities, are asbestos, clay products, coal (lignite), mineral waters, phosphate rock, pumice, salt, building stone, sand-lime brick, sand, and gravel. The deposits of phosphate rock in southeastern Idaho, which extend over into northeastern Utah and southwestern Wyoming, give promise of becoming one of the important mineral resources of that tri-State section as the agricultural industries of the Western States are developed.

The output and value of the mineral production of Idaho by substances in 1910 and 1911 are shown in the following table:

*Mineral production of Idaho in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Asbestos, short tons | (a) | (a) | | | | | | |
| Clay products, do | (a) (b) | (a) (b) | | (a) | (a) (b) | (a) (b) | | (a) |
| Coal, short tons | 4,448 | $17,426 | | | 1,805 | $4,808 | | |
| Copper, pounds | | | 6,877,515 | $873,444 | | | 4,514,116 | $564,265 |
| Gold, fine ounces (troy) | | | 50,112 | 1,035,900 | | | 65,688 | 1,357,900 |
| Lead, short tons | | | 99,924 | 8,793,312 | | | 117,159 | 10,544,310 |
| Lime, do | | | 8,094 | 48,298 | | | 6,809 | 38,088 |
| Mineral water, gallons sold | (a) | (a) | | | (a) | (a) | | |
| Phosphate rock, long tons | (a) | (a) | | | (a) | (a) | | |
| Salt, barrels | 350 | 386 | 535 | 741 | 71 | 120 | 243 | 412 |
| Sand and gravel, short tons | 32,675 | 24,450 | | | (a) | (a) | | |
| Sand-lime brick | | | | (a) | | | | (a) |
| Silver, fine ounces (troy) | | | 7,027,000 | 3,794,600 | | | 8,184,900 | 4,419,800 |
| Stone | | (c) | | c 57,277 | | (c) | | c 64,250 |
| Tungsten ore (60 per cent concentrates), short tons | | | | | | | (a) | (a) |
| Zinc, short tons | | | 3,454 | 373,032 | | | 3,180 | 362,520 |
| Miscellaneous | | 52,844 | | 365,773 | | 60,666 | | 171,576 |
| Total value, eliminating duplications | | $15,437,403 | | | | $17,588,349 | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product includes stone sold rough.

## ILLINOIS.

Illinois ranks second or third among the States in the value of its mineral production according to whether pig iron or iron ore is taken as the basis of output and value. Illinois produces no iron ore, but its output of pig iron, derived from ores from the Lake Superior iron ranges, amounts in value to between $40,000,000 and $50,000,000 annually. The only two States whose production of pig iron exceeds Illinois are Pennsylvania and Ohio. These two States produce a small quantity of iron ore, but Illinois gets all of its raw material from Lake Superior. Pennsylvania and Ohio also secure the larger part of their ores from the same source. With pig iron as the basis, the value of the mineral output of Illinois in 1910 was $140,237,550 and in 1911 it was $137,384,382. Eliminating pig iron the values were for the two years, respectively, $98,772,007 and $106,231,455. The latter figures are considered in this summary review.

The principal raw mineral product of Illinois is coal, in which the State ranks third in the quantity produced and second in the value of the product. The value of the coal mined in Illinois in 1910 and in 1911 was considerably more than half the total value of the State's mineral output. Coal is mined in 51 counties in Illinois, just half

the total number of counties in the State. The counties accredited with the largest production are in the southern part of the State and in the southwestern part, adjacent to the city of St. Louis, though in the northern part of the State where the mines are closer to the Chicago markets large mining operations are also carried on. Two counties, St. Clair and Williamson, produce over 5,000,000 tons; two others, Madison and Sangamon, exceed 4,000,000 tons; one, Macoupin, exceeds 3,000,000 tons; two, Saline and Vermilion, exceed 2,500,000 tons; and several others produce over 1,000,000 tons. The total production of coal in Illinois in 1911 was 53,679,118 short tons, valued at $59,519,478, an increase from 45,900,246 tons, valued at $52,405,897, in 1910. Illinois is also a producer of coke, ranking fourth among the States in this respect, but at least 80 per cent of the raw coal used in the coke ovens comes from West Virginia, some Illinois coal being mixed with it.

Next to coal the principal product of Illinois is petroleum, in the production of which the State ranks third. The discovery of petroleum in quantity in Illinois is a part of the history of the last decade, a few hundred barrels being the maximum yearly output until 1905, when oil in quantity was struck. The next year, 1906, the production rose to 4,400,000 barrels; in 1907 it rose still further to over 24,000,000 barrels, and reached the maximum output of 33,686,238 barrels in 1908. The production in 1911 was 31,317,038 barrels, valued at $19,734,339, against 33,143,362 barrels, valued at $19,669,383 in 1910. The principal petroleum producing counties are Lawrence, Crawford, Clark, Clinton, Marion, and Cumberland.

Next to the fuels the clay-working industries contribute most to the mineral production of the State, with a total value of $15,176,161 in 1910 and $14,333,011 in 1911. Clay products might be made in any of the 102 counties of the State. The clay is everywhere, and the fuel is abundant and cheap. The clay-working industry is concentrated in a large measure, however, in Cook County, which contributes over one-third the total for the State. Lasalle, Knox, Vermilion, Kankakee, and Livingston counties exceed $500,000 in the value of their clay products. The principal products are building brick, vitrified brick, drain tile, and architectural terra cotta, though nearly every variety of clay product is made. According to the Thirteenth Census of the United States, Illinois ranks third in the total value of its manufactures; it ranks fourth in the manufacture of clay products. Two other industries of importance in Illinois are the manufacture of cement and quarrying. The cement plants, which are all located in the northern part of the State convenient to the Chicago market and the water transportation on Lake Michigan, had outputs valued at $4,119,012 in 1910 and $3,583,301 in 1911. Limestone is the principal quarry product, and Cook, Kankakee, Vermilion and Will counties are the leading producers.

Illinois is the leading State in the production of fluorspar, mined at Rosiclare in the southern part of the State, and second in the production of tripoli. Other mineral products of the State are glass sand and other sand, gravel, lead, lead pigments, zinc, zinc oxide, lime, mineral waters, natural gas, pyrite (a by-product in coal mining), and silver. The statistics of production in the last two years are presented in the following table:

*Mineral production of Illinois in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Asphalt..short tons | | | | | | | (a) | (a) |
| Briquets, fuel..do | | | (b) | (b) | | | (a) (c) | (a) (c) |
| Cement, Portland,d barrels | | | 4,459,450 | $4,119,012 | | | 4,582,341 | $3,583,301 |
| Clay products, short tons | 188,803 | c $190,896 | | 15,176,161 | 182,836 | c $183,826 | | 14,333,011 |
| Coal.....short tons | 45,900,246 | 52,405,897 | | | 53,679,118 | 59,519,478 | | |
| Coke.....do | | | 1,514,504 | c6,712,550 | | | (a) (c) | (a) (c) |
| Ferro-alloys, long tons | | | (a) (c) | (a) (c) | | | (a) (c) | (a) (c) |
| Fluorspar, short tons | 47,302 | 277,764 | | | 68,817 | 481,635 | | |
| Gypsum.....do | | | | | | | | (e) |
| Iron, pig..long tons | | | 2,606,335 | c41,465,543 | | | 2,036,081 | c31,152,927 |
| Lead.....short tons | | | 262 | 23,056 | | | 308 | 27,720 |
| Lime.....do | | | 113,239 | 503,581 | | | 92,169 | 423,762 |
| Mineral paints, zinc-lead pigments, short tons | | | (a) | (a) | | | | |
| Mineral waters, gallons sold | 1,117,620 | 83,148 | | | 1,304,950 | 82,330 | | |
| Natural gas | | 613,642 | | | | 687,726 | | |
| Petroleum...barrels | 33,143,362 | 19,669,383 | | | 31,317,038 | 19,734,339 | | |
| Pyrite....long tons | 8,541 | 28,159 | | | 17,441 | 47,020 | | |
| Sand and gravel, short tons | 8,586,508 | 1,730,795 | | | 8,488,683 | 1,990,922 | | |
| Silver, fine ounces, (troy) | | | 2,000 | 1,100 | | | 4,000 | 2,200 |
| Stone | | 1,213,317 | | 2,640,108 | | (f) | | f3,467,930 |
| Sulphuric acid (60° Baumé),g short tons | | | | (b) | | | 144,805 | 958,591 |
| Tripoli | | | | 33,390 | | | | 45,910 |
| Zinc.....short tons | | | 1,551 | 167,508 | | | 2,884 | 328,776 |
| Miscellaneous | | | | 1,560,547 | | | | 7,756,705 |
| Total value, eliminating duplications | $98,772,007 | | | | $106,231,455 | | | |

a Value included under "Miscellaneous."
b No report for 1910.
c Value not included in total value.
d Natural cement included under "Miscellaneous."
e Not mined, but calcined, in Illinois. Value included under "Miscellaneous."
f Derived product includes stone sold rough.
g From zinc smelters.

## INDIANA.

Indiana ranks fifteenth among the States in the value of its mineral production, with a total in 1911 of $37,430,187. In 1910 the value of the mineral products aggregated $44,904,701. These values are exclusive of pig iron, which in the last two years, because of the operations of the United States Steel Corporation at Gary, has become an important industry in the State. If pig iron be included, the value of the mineral production would show an increase of about 30 per cent over the figures given for 1910 and 34 per cent over those for 1911. The principal mineral product of the State is coal, in the production of which Indiana ranked fifth among the States in 1910 and sixth in 1911. Indiana's coal production in 1910, owing to the prolonged strike among the miners in Illinois, reached its highest record, with an output of 18,389,815 short tons, valued at $20,813,659, decreasing in 1911 to 14,201,355 short tons, valued at

$15,326,808. In 1910 the coal production represented 45 per cent of the State's total; in 1911 it represented 41 per cent. The coal production of Indiana in 1910 was nearly 10 times what it was in 1882. The three principal coal-producing counties are Green, Sullivan, and Vigo, each of which has exceeded 3,000,000 tons a year, and the last two in 1910 produced over 4,000,000 tons. Only three other counties—Clay, Knox, and Vermilion—have produced as much as 1,000,000 tons a year. Next to coal mining the clay-working industries are the most important, Indiana in this respect having the same rank as in coal. The value of the clay products amounted to $8,100,010 in 1910 and to $7,000,771 in 1911. The leading counties in the manufacture of clay products are Clay, Lake, Madison, Vigo, Parke, Vermilion, Marion, and Morgan. The principal clay products are drain tile, common brick, and encaustic tile. In the manufacture of encaustic tile Indiana ranks third among the States. Third in importance among the mining industries of the State is the manufacture of Portland cement, in which Indiana ranks second among the States in the quantity produced, being exceeded only by Pennsylvania. In value Indiana's production falls below California. In 1910 the production of Portland cement in Indiana amounted to 7,219,199 barrels, valued at $6,487,508, and in 1911 it was 7,407,830 barrels, valued at $5,937,241. The centers of cement production are Stroh and Syracuse in the northern part of the State, and Mitchell and Speeds in the southern part. The quarry products rank fourth in the value of output, the value of the stone produced in 1911 amounting to $4,413,655, against $4,476,382 in 1910. "Bedford" limestone quarried in Lawrence and Monroe counties is highly prized for structural purposes and forms the principal stone product of the State.

Since the completion in 1911 of the plant of Koppers by-product coke ovens by the United States Steel Corporation at Gary Indiana has assumed importance as a manufacturer of coke, ranking sixth among the States in that year. The coal for these ovens is, however, like most of that consumed in Illinois, drawn from West Virginia mines. Petroleum, in which Indiana ranks ninth, and natural gas, in which it ranks seventh, add about $3,000,000 to the State's mineral output. Other mineral products are lime, mineral waters, oilstones, sand-lime brick, pyrite, sand, and gravel, as shown in the following table:

*Mineral production of Indiana in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Briquets, fuel, short tons | ..... | ..... | (a) | (a) | ..... | ..... | (b) (d) | (b) (d) |
| Cement, Portland, c barrels | ..... | ..... | 7,219,199 | $6,487,508 | ..... | ..... | 7,407,830 | $5,937,241 |
| Clay products, short tons | 88,176 | b $80,829 | ..... | 8,100,010 | 61,992 | b $54,918 | ..... | 7,000,771 |
| Coal...short tons | 18,389,815 | 20,813,659 | ..... | ..... | 14,201,355 | 15,326,808 | ..... | ..... |
| Coke.....do | ..... | ..... | b 84,046 | b 269,315 | ..... | ..... | (b) (d) | (b) (d) |
| Gems and precious stones | ..... | ..... | ..... | 100 | ..... | ..... | ..... | 20 |
| Iron, pig, long tons | ..... | ..... | b 830,938 | b12,879,539 | ..... | ..... | b 851,485 | b12,772,275 |
| Lime...short tons | ..... | ..... | 86,811 | 301,304 | ..... | ..... | 92,229 | 324,950 |
| Mineral paints, natural pigments, short tons | ..... | ..... | ..... | ..... | ..... | ..... | (d) | (d) |
| Mineral waters, gallons sold | 754,111 | 514,958 | ..... | ..... | 1,084,428 | 653,641 | ..... | ..... |
| Natural gas | ..... | 1,473,403 | ..... | ..... | ..... | 1,192,418 | ..... | ..... |
| Oilstones | ..... | ..... | ..... | (d) | ..... | ..... | ..... | 18,151 |
| Petroleum, barrels | 2,159,725 | 1,568,475 | ..... | ..... | 1,695,289 | 1,228,835 | ..... | ..... |
| Pyrite...long tons | (d) | (d) | ..... | ..... | (d) | (d) | ..... | ..... |
| Sand and gravel, short tons | 6,418,468 | 1,045,162 | ..... | ..... | 6,033,159 | 1,133,829 | ..... | ..... |
| Sand-lime brick | ..... | ..... | ..... | 63,534 | ..... | ..... | ..... | 45,891 |
| Stone | ..... | 1,412,372 | ..... | 3,064,010 | ..... | (e) | ..... | e4,413,655 |
| Sulphuric acid (60° Baumé), f short tons | ..... | ..... | ..... | (a) | ..... | ..... | (f) | (f) |
| Miscellaneous | ..... | (e) | ..... | e 329,521 | ..... | (e) | ..... | e 3,779,172 |
| Total value, eliminating duplications. | $44,904,701 | | | | $37,430,187 | | | |

a No report for 1910.
b Value not included in total value.
c Natural cement included under "Miscellaneous."
d Value included under "Miscellaneous."
e Derived product includes raw product.
f From zinc smelters. Value included under "Miscellaneous."

## IOWA.

The total value of the mineral products of Iowa was $21,107,496 in 1911, against $22,730,968 in 1910. Coal mining and clay working are the principal industries, these two contributing 85 per cent of the total value. Coal is mined in 21 different counties, of which the principal ones are, in order, Monroe, Polk, Appanoose, and Mahaska. The coal-mining operations are chiefly on a moderate scale, there being but 25 mines in the State having an output in excess of 100,000 tons; and although Iowa was probably the second State west of Mississippi River in priority as a coal producer (production dating back to 1840), the industry in this State has not shown the same progress as in many other States east or west of that boundary. The production of coal in Iowa in 1911 was less than double that of 1882, whereas the total production of coal in the Western States in 1911 was about 10 times that of 1882. The reason for this probably lies in the fact that Iowa is largely an agricultural State and manufactures have not been extensively developed. The State ranks eighteenth in the value of its manufactures and twentieth in the value of its mineral output. The coal production of the State amounted

to 7,331,648 short tons, valued at $12,663,507, in 1911, against 7,928,120 tons, valued at $13,903,913, in 1910.

The clay-working industries, in which Iowa ranks eighth among the States, produced wares to the value of $5,328,241 in 1910 and $4,432,874 in 1911. The principal products are drain tile, in which Iowa holds first place among the States, and common brick. The principal producing counties are Webster, Cerro Gordo, Polk, and Woodbury. The branch of the mining industry in which Iowa ranks relatively highest is in the production of gypsum. In this respect Iowa holds second place among the States, and the value of the gypsum products is third in importance in the State's total, amounting in 1910 to $943,849 and in 1911 to $871,752. The other commercial mineral products are stone, lime, mineral pigments, mineral waters, sand-lime brick, cement, natural gas, sand, and gravel. The production of the different minerals in 1910 and 1911 as far as they may be published separately was as follows:

*Mineral production of Iowa in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Briquets, fuel, short tons | ..... | ..... | (a) | (a) | ..... | ..... | (b) (c) | (b) (c) |
| Cement.....barrels | ..... | ..... | (c) | (c) | ..... | ..... | 1,952,590 | $1,881,253 |
| Clay products, short tons | 12,640 | b $5,153 | ..... | $5,328,241 | 9,643 | b $3,965 | ..... | 4,432,874 |
| Coal.....short tons | 7,928,120 | 13,903,913 | ..... | ..... | 7,331,648 | 12,663,507 | ..... | ..... |
| Gypsum.....do | 322,713 | ..... | ..... | 943,849 | 354,204 | ..... | ..... | 871,752 |
| Lime.....do | ..... | ..... | 15,481 | 81,775 | ..... | ..... | 14,791 | 80,914 |
| Mineral paints, natural pigments, short tons | ..... | ..... | (c) | (c) | ..... | ..... | (c) | (c) |
| Mineral waters, gallons sold | 253,100 | 27,175 | ..... | ..... | 176,000 | 20,500 | ..... | ..... |
| Natural gas | ..... | 40 | ..... | ..... | ..... | 70 | ..... | ..... |
| Sand and gravel, short tons | 1,798,762 | 464,427 | ..... | ..... | 1,349,004 | 393,649 | ..... | ..... |
| Sand-lime brick | ..... | ..... | ..... | 31,269 | ..... | ..... | ..... | (c) |
| Stone | ..... | 186,680 | ..... | 371,376 | ..... | (d) | ..... | d 736,207 |
| Zinc.....short tons | ..... | ..... | 40 | 4,320 | ..... | ..... | ..... | ..... |
| Miscellaneous | ..... | ..... | ..... | 1,387,903 | ..... | ..... | ..... | 27,970 |
| Total value, eliminating duplications | $22,730,968 | | | | $21,107,496 | | | |

a No report for 1910.
b Value not included in total value.
c Value included under "Miscellaneous."
d Derived product includes stone sold rough.

## KANSAS.

The principal mineral products of Kansas are the two fuels, coal and natural gas. Some petroleum is produced, but the quantity and the value of the output are relatively small. The value of the coal and gas considerably exceeds 50 per cent of the State's total in mineral production. The coal productive area is entirely in the eastern part of the State, and the two leading coal-producing counties, Cherokee and Crawford (credited with 90 per cent of the total), are in the extreme southeast corner. The principal counties in the production of natural gas are Chautauqua and Montgomery, also in the south-

eastern part of the State. The development of the gas resources of Kansas is largely a part of the history of the last decade, for although some gas was produced in the State as early as 1886, it did not assume any importance until 1901, when the value amounted to $660,000. In 1911 the value of the natural gas produced in Kansas was $4,854,534. It reached its highest point in 1909, when the output was valued at $8,293,846. The deficiency in 1911 was made up from gas drawn from Oklahoma. Coal production in Kansas began in 1869. In 1882, the first year for which Mineral Resources was published, the production was estimated at 750,000 tons. The maximum production was attained in 1907, with an output of 7,322,449 tons. In 1910 coal production in Kansas, as in other Mississippi Valley States, was seriously curtailed by the miners' strike, and amounted to only 4,921,451 tons, from which recovery to 6,254,228 tons was made in 1911.

The total value of the mineral production of Kansas was $28,304,191 in 1910 and $24,987,807 in 1911, the distribution by substances being as follows:

*Mineral production of Kansas in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Cement, Portland,[a] barrels | | | 5,655,808 | $5,359,408 | | | 4,871,903 | $3,725,108 |
| Clay products | | | | [b]2,661,527 | | | | [b]2,360,262 |
| Coal.....short tons | 4,921,451 | $7,914,709 | | | 6,254,228 | $9,645,572 | | |
| Coke.....do | | | (c) (d) | (c) (d) | | | (c) (d) | (c) (d) |
| Gypsum.....do | 135,088 | | | 370,695 | 122,579 | | | 319,504 |
| Lead.....do | | | 1,308 | 115,104 | | | 2,522 | 226,980 |
| Lime.....do | | | 1,510 | 7,503 | | | 648 | 3,440 |
| Mineral paints, zinc-lead pigments, short tons | | | (d) | (d) | | | (d) | (d) |
| Mineral waters, gallons sold | 591,004 | 82,307 | | | 456,341 | 63,063 | | |
| Natural gas | | 7,755,367 | | | | 4,854,534 | | |
| Petroleum...barrels | 1,128,668 | 444,763 | | | 1,278,819 | 608,756 | | |
| Pumice..short tons | (d) | (d) | | | (d) | (d) | | |
| Salt.....barrels | 1,338,357 | 266,058 | 1,473,091 | 681,311 | 769,691 | 197,361 | 1,390,168 | 608,666 |
| Sand and gravel, short tons | 776,638 | 165,659 | | | 734,507 | 164,058 | | |
| Sand-lime brick | | | | (d) | | | | (d) |
| Stone | | 121,583 | | 672,847 | | (c) | | [e]803,222 |
| Sulphuric acid (60° Baumé) [f], short tons | | | | (f) | | | (f) | (f) |
| Zinc.....short tons | | | 10,220 | 1,103,760 | | | 6,843 | 780,102 |
| Miscellaneous | | (c) | | [e]582,590 | | (c) | | [e]629,104 |
| Total value, eliminating duplications | $28,304,191 | | | | $24,987,807 | | | |

[a] Natural cement included under "Miscellaneous."
[b] Exclusive of pottery, which is included under "Miscellaneous."
[c] Value not included in total value.
[d] Value included under "Miscellaneous."
[e] Derived product includes raw product.
[f] From zinc smelters. No report for 1910. Value included under "Miscellaneous."

The development of the gas pools of Kansas and Oklahoma has built up another important industry in Kansas—the manufacture of cement. The output of the cement works ranks third in value among

the mineral products of the State, and Kansas ranks fourth among the States in the quantity and value of cement produced. The cement plants are, with two exceptions, in the southeastern corner of the State, the largest activity being in the vicinity of Independence, in Montgomery County. The production of cement in Kansas decreased from 5,655,808 barrels, valued at $5,359,408, in 1910, to 4,871,903 barrels, valued at $3,725,108, in 1911.

Natural gas has also influenced the clay-working industry in Kansas, but chiefly in lowering the cost of manufacture. The clay products of Kansas, exclusive of pottery, were valued at $2,661,527 in 1910 and at $2,360,262 in 1911. The principal product from the clay-burning kilns is vitrified brick, in the production of which Kansas ranks fourth among the States. The average price of this brick in Kansas in 1911 was $9.88 per thousand, a lower average than in any State except Arkansas for the year. Common brick is second among the clay products, the output in 1911 being valued at $694,586, at the average rate of $3.78 per thousand, the lowest average price for this class of clay product in the United States. The principal clay-producing counties are Montgomery, Crawford, and Wilson.

Other important industries in Kansas are zinc mining, salt mining and evaporating, stone quarrying, and the mining and calcining of gypsum. In the production of salt Kansas ranks fourth among the States, and in the mining of zinc it stands sixth. Less important mineral products of Kansas are lead, lime, mineral waters, sand and gravel, pumice, sand-lime brick, and zinc and lead pigments.

## KENTUCKY.

The principal mineral product of Kentucky is coal, the value of which constitutes about two-thirds of the State's total. In 1910 the total value of Kentucky's mineral production was $19,883,476, of which the coal output made up $14,405,887, and in 1911 out of $18,910,731 the coal mines contributed $13,617,217. The coal-producing areas of Kentucky are found in the extreme eastern counties and in the more northern counties in the western part of the State. The coal beds in the eastern part of the State belong to the Appalachian system, whereas those in the western part of the State belong to the eastern interior field, the larger part of which lies across Ohio River in Illinois and Indiana on the north. The production has been nearly evenly divided between the two sections, the western areas having somewhat the better of it up to the close of 1911. The supremacy of the western counties has, however, about ceased, as extensive developments are in progress in Pike, Johnson, and other counties in the eastern part of the State, following the extension of branches of several railroad systems into those counties, and the next few years will record substantial increases from that section. At the present time Bell, Whitley, Knox, and Johnson counties are the largest producers in the eastern part of the State, and Muhlenberg, Hopkins, Webster, Ohio, and Union counties are the principal producers in the western part of the State. In 1911 the coal production of Kentucky was 13,706,839 short tons, of which the eastern counties produced 6,595,102 tons and the western counties 7,111,737 tons. Coal mining in Kentucky began in the third decade of the last century, and so far as known Kentucky was the third State to enter

the list of coal producers, but it was not until the State began to recover from the effects of the Civil War that coal mining became an industry of any importance. Up to 1875 the production in any one year had not amounted to half a million tons, but the census of 1880 showed an output of 946,288 tons. In 1882 the production was estimated at 1,300,000 tons, about one-tenth that of the present time.

The clay-working industry is second in importance in the State, with from 12 to 15 per cent of the total value. The principal clay products are firebrick and common brick, and the principal producing counties are Jefferson, Carter, Kenton, and Boyd. The clay products in 1910 were valued at $2,567,537, and in 1911 they were valued at $2,368,094.

The statistics of the mineral production in 1910 and 1911, by substances, as far as they can be published separately, are given in the following table:

*Mineral production of Kentucky in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Asphalt..short tons.. | 9,938 | $53,703 | 1,287 | $12,226 | (a) | (a) | (a) | (a) |
| Barytes.....do.... | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Cement.....barrels.. | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Clay products, short tons..... | 80,420 | b $5,655 | ..... | 2,567,537 | 131,801 | b $126,457 | ..... | $2,368,094 |
| Coal.....do.... | 14,623,319 | 14,405,887 | ..... | ..... | 13,706,839 | 13,617,217 | ..... | ..... |
| Coke.....do.... | ..... | ..... | 53,857 | b 120,554 | ..... | ..... | 66,099 | b 134,862 |
| Ferro-alloys, long tons..... | ..... | ..... | (a) (b) | (a) (b) | ..... | ..... | (a) (b) | (a) (b) |
| Fluorspar..short tons.. | 17,003 | 124,574 | ..... | ..... | 12,403 | 96,574 | ..... | ..... |
| Iron ore...long tons.. | 51,193 | 63,066 | ..... | ..... | 63,770 | 78,212 | ..... | ..... |
| Iron, pig.....do.... | ..... | ..... | 81,677 | b 1,312,288 | ..... | ..... | 57,982 | b 870,542 |
| Lead.....short tons.. | ..... | ..... | 50 | 4,400 | ..... | ..... | ..... | ..... |
| Lime.....do.... | ..... | ..... | 3,622 | 12,468 | ..... | ..... | 4,365 | 15,121 |
| Mineral paints, natural pigments, short tons..... | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Mineral waters, gallons sold..... | 403,736 | 55,195 | ..... | ..... | 423,729 | 49,827 | ..... | ..... |
| Natural gas..... | ..... | 456,293 | ..... | ..... | ..... | 407,689 | ..... | ..... |
| Oilstones..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | (a) |
| Petroleum...barrels.. | 468,774 | 324,684 | ..... | ..... | 472,458 | 328,614 | ..... | ..... |
| Phosphate rock, long tons..... | ..... | ..... | ..... | ..... | (a) | (a) | ..... | ..... |
| Sand and gravel, short tons..... | 737,350 | 386,446 | ..... | ..... | 906,905 | 389,568 | ..... | ..... |
| Sand-lime brick..... | ..... | ..... | ..... | (a) | ..... | ..... | ..... | (a) |
| Silver, fine ounces (troy)..... | ..... | ..... | (a) | (a) | ..... | ..... | ..... | ..... |
| Stone..... | ..... | (c) | ..... | c 1,073,588 | ..... | (c) | ..... | c 1,227,609 |
| Zinc.....short tons.. | ..... | ..... | 29 | 3,132 | ..... | ..... | 205 | 23,370 |
| Miscellaneous..... | ..... | (c) | ..... | 800,277 | ..... | 35,095 | ..... | 704,779 |
| Total value, eliminating duplications..... | $19,883,476 | | | | $18,910,731 | | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product includes raw product.

The quarrying industry is third in importance and is confined to the production of limestone, most of which is crushed for road making, railroad ballast, and concrete.. The principal producing counties are Fayette, Jefferson, Jessamine, Rock Castle, Warren, and

Caldwell. The total production of stone in 1911 was valued at $1,227,609, against $1,073,588 in 1910. Natural gas was produced to the value of $456,293 in 1910 and of $407,689 in 1911, and petroleum to the value of $324,684 in 1910 and of $328,614 in 1911 was produced in Barren, Bath, Floyd, Knott, Logan, Rowan, Wayne, and Wolf counties. Kentucky is second among the States in the production of fluorspar and third in the production of barytes. The former is mined in Crittenden and Livingston counties and the latter in Boyle, Fayette, Garrard, and Lincoln counties. Other mineral products of the State are asphalt, cement, iron ore, lead, lime, mineral waters, mineral paints, oilstones, phosphate rock, sand and gravel, sand-lime brick, silver, and zinc. A small quantity of lithographic stone was quarried at Brandenburg in 1911.

## LOUISIANA.

It is only during the last 10 years that Louisiana has attained any prominence as a mineral-producing State. Following the sensational strike of oil at Beaumont, Tex., in 1901, prospecting for petroleum was actively carried on across Sabine River in Louisiana, resulting in the discovery and development of several pools in the vicinity of Jennings. Since that time productive areas have been developed in many parts of the State, and Louisiana now ranks eighth among the States in the production of petroleum. The Caddo district, opened in 1906, is the principal producer at the present time and of greatest promise for the future. It is located in Caddo Parish in the northwestern part of the State, about 200 miles from the place of original discovery of oil near Jennings. The production of petroleum in Louisiana amounted to 6,841,395 barrels, valued at $3,574,069, in 1910, and to 10,720,420 barrels, valued at $5,668,814, in 1911.

In one respect Louisiana stands preeminently first among the States. This is in the production of sulphur. In 1904 the Frasch process for the recovery of sulphur from beds lying under a heavy cover of quicksand was put into successful operation by the Union Sulphur Co. at Sulphur City, about 12 miles west of Lake Charles, in Calcasieu Parish. Since that time approximately 1,000,000 tons of refined sulphur have been recovered. Prior to this the only domestic source of sulphur in quantity in the United States was iron pyrites, from which sulphuric acid is made direct. Nearly all the sulphur used was imported from Sicily. At the present time the domestic output of refined sulphur, except that from Louisiana, is a negligible quantity. The imports of sulphur into the United States in 1903 were valued at $3,709,690; in 1911 they were valued at $552,836.

In addition to petroleum and sulphur Louisiana is an important producer of rock salt, in which the State also ranks first. The salt mines underlie so-called "islands," really mounds rising above the marshlands along the Gulf shore in Iberia Parish. The Petite Anse mines on Avery Island were operated during the Civil War, having been developed in a small way in 1862. This mine was flooded twice, and a new shaft was sunk in 1899. Mining on Weeks Island was begun in 1902. In the total production of salt, including that evaporated from brine, Louisiana ranks sixth among the States.

Louisiana's clay products, exclusive of pottery, were valued at $546,873 in 1910 and at $531,949 in 1911. The principal clay product is common brick. The other mineral products are mineral waters, natural gas, pottery, stone, sand, and gravel.

The production of the State in 1910 and 1911 is shown in the following table:

*Mineral production of Louisiana in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products | | | | [a] $546,873 | | | | [a] $531,949 |
| Mineral waters, gallons sold | 2,313,000 | $163,975 | | | 1,520,550 | $110,998 | | |
| Natural gas | | [b] | | | | [b] | | |
| Petroleum...barrels | 6,841,395 | 3,574,069 | | | 10,720,420 | 5,668,814 | | |
| Salt.....do | [b] | [b] | | | [b] | [b] | | |
| Sand and gravel, short tons | 835,295 | 372,336 | | | 969,259 | 344,281 | | |
| Stone | | [c] | | [b] | | [c] | | [b] |
| Sulphur...long tons | [b] | [b] | | | [b] | [b] | | |
| Miscellaneous | | 5,423,510 | | 39,224 | | 5,953,897 | | 101,019 |
| Total value, eliminating duplications | $10,119,993 | | | | $12,710,958 | | | |

[a] Exclusive of pottery, which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Derived product includes stone sold rough.

## MAINE.

The total value of the mineral production of Maine is less than $5,000,000, and it ranks thirty-ninth as a mining State, but in one mineral product, feldspar, it holds first place. Feldspar is mined in Androscoggin, Oxford, and Sagadahoc counties. In 1911 Maine produced 24 per cent of the quantity and 42 per cent of the value of the feldspar produced in the United States. The principal mineral product of the State, however, is granite, in the production of which Maine ranks second among the States, being exceeded only by Vermont. Approximately one-half of the total value of the mineral production of Maine is represented by the output of its granite quarries, which are located in Franklin, Hancock, Kennebec, Knox, and Waldo counties. The stone production was valued at $2,320,018 in 1910 and at $2,263,200 in 1911. Maine is also one of the three leading States in the production of slate, quarried in Piscataquis County, and it ranks fourth among the States in the production of lime, the value of which in 1910 was $893,599, and in 1911, $773,212. The other commercial mineral products are manufactures from clay, including pottery, gems (intermittently), mineral waters, sand, and gravel.

The production of minerals in Maine during 1910 and 1911 is shown in the following table:

*Mineral production of Maine in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products | ..... | ..... | ..... | $605,881 | ..... | ..... | ..... | $625,214 |
| Feldspar, short tons | 20,762 | $196,463 | ..... | ..... | 25,976 | $246,305 | ..... | ..... |
| Gems and precious stones | ..... | ..... | ..... | 3,305 | ..... | ..... | ..... | 12,355 |
| Lime, short tons | ..... | ..... | 179,656 | 893,599 | ..... | ..... | 152,552 | 773,912 |
| Mineral waters, gallons sold | 1,238,171 | 404,539 | ..... | ..... | 1,254,783 | 431,740 | ..... | ..... |
| Sand and gravel, short tons | 41,569 | 40,313 | ..... | ..... | 33,308 | 30,088 | ..... | ..... |
| Slate | ..... | ..... | ..... | 249,005 | ..... | ..... | ..... | 263,516 |
| Stone | ..... | (a) | ..... | a2,320,018 | ..... | (a) | ..... | a2,263,200 |
| Total value, eliminating duplications | $4,713,123 | | | | $4,645,630 | | | |

a Derived product includes stone sold rough.

## MARYLAND.

Exclusive of pig iron, the value of the mineral production of Maryland was $10,238,488 in 1910 and $9,386,663 in 1911. If pig iron, most of which is from ore mined in other States or from ore imported from foreign countries, be included, the value of the product would be increased approximately 50 per cent.

The principal mineral product of Maryland is coal, mined in Allegany and Garrett counties in the western part of the State. The value of the output of the coal mines approximates one-half the value of the State's total. Coal mining in Maryland began early in the last century, the first coal being shipped by barges on Potomac River as early as 1830. Mining had begun, however, 10 or 12 years earlier. The first company was incorporated in 1836. The "Big Vein" of Maryland, from which most of the coal has been produced, is approaching exhaustion, and operations in the future will be chiefly in the smaller and deeper beds. The industry has remained practically stationary during the last 10 years. The production in 1911 was 4,685,795 short tons, and the average for the 10 years ending with 1910 was 4,973,860 tons.

Next to coal the clay-working industry is the most important branch of mining in Maryland, 18 per cent of the total value being from the clay pits. The principal clay product is building brick, and the principal producing locality is in the vicinity of Baltimore. Third in importance are the quarries, which yield 10 per cent of the total value. The principal stone quarried is granite, the quarries being located in Cecil, Harford, Howard, Montgomery, and Baltimore counties and in Baltimore City. Other commercial mineral products are feldspar, cement, copper, iron ores, lime, mineral pigments, mineral waters, infusorial earth, quartz, slate, sand-lime brick, talc, sand, and gravel.

The quantity and value of the minerals produced in Maryland during 1910 and 1911 are shown in the following table:

*Mineral production of Maryland in 1910 and 1911.*

| Product. | 1910. | | | | 1911. | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Briquets, fuel, short tons | | | (a) | (a) | | | (b) (c) | (b) (c) |
| Cement, barrels | | | (c) | (c) | | | (c) | (c) |
| Clay products, short tons | 22,696 | b $46,143 | | $1,848,273 | 12,323 | b $28,123 | | $1,772,434 |
| Coal, short tons | 5,217,125 | 5,835,058 | | | 4,685,795 | 5,197,066 | | |
| Coke, do | | | (b) (c) | (b) (c) | | | (b) (c) | (b) (c) |
| Copper, pounds | | | | | | | 23,555 | 2,944 |
| Feldspar, short tons | 9,977 | 47,340 | | | 12,694 | 56,265 | | |
| Infusorial earth | | | | (c) | | | | (c) |
| Iron ore, long tons | 14,062 | 29,105 | | | (c) | (c) | | |
| Iron, pig, do | | | b 326,214 | b 5,230,824 | | | b 222,420 | b 3,467,789 |
| Lime, short tons | | | 121,555 | 377,236 | | | 114,386 | 362,839 |
| Mineral paints, natural pigments, short tons | | | (c) | (c) | | | (c) | (c) |
| Mineral waters, gallons sold | 1,163,828 | 102,371 | | | 1,657,756 | 150,966 | | |
| Quartz, short tons | 8,614 | 50,410 | | | 7,977 | 34,286 | | |
| Sand and gravel, short tons | 954,393 | 396,357 | | | 482,152 | 246,486 | | |
| Sand-lime brick | | | | (c) | | | | (c) |
| Slate | | | | 78,573 | | | | 76,035 |
| Stone | | (d) | | d 1,205,761 | | (d) | | d 1,133,339 |
| Talc and soapstone, short tons | | | (c) | (c) | | | (c) | (c) |
| Miscellaneous | | | | 1,607,877 | | (d) | | d 1,704,217 |
| Total value, eliminating duplications | | $10,238,488 | | | | $9,336,663 | | |

a No report for 1910.
b Value not included in total value.
c Value included under "Miscellaneous."
d Derived product includes raw product.

## MASSACHUSETTS.

The principal mineral products of Massachusetts are stone and clay. About one-half the total value of the mineral production is furnished by the stone quarries, exclusive of limestone burned into lime. The clay products furnish from 25 to 30 per cent of the total, and lime adds from 10 to 15 per cent. Approximately one-half of the quarry product is granite, of which the principal producing counties are Bristol, Essex, Middlesex, Norfolk, and Worcester. The production of trap rock in Essex, Hampden, Middlesex, Norfolk, and Suffolk counties yields values about half that of granite, and the other fourth is made up by sandstone and marble in the proportion of two to one. Sandstone is quarried in Hampden and Suffolk counties, and marble in Berkshire and Hampden counties. The principal clay products are common brick and brick for stove lining, and the principal producing counties are Bristol, Middlesex, Hampden, Suffolk, and Essex. The lime industry is independent of the marble quarries and is located chiefly in Berkshire County in the extreme western part of the State. Massachusetts ranks sixth among the States in the manufacture of lime; it is eighth in the total production of stone. Other products to which the State contributes are fuller's

earth, mineral waters, talc and soapstone, feldspar, sand and gravel, infusorial earth, mica, pyrite, and quartz. A small quantity of iron ore is mined and a small quantity of pig iron is produced in the State. The total value of the mineral production of Massachusetts in 1911 was $6,623,077, against $5,903,976 in 1910. The quarry products were valued at $2,870,640 in 1910 and at $3,691,747 in 1911; the clay products at $1,707,413 in 1910 and at $1,700,287 in 1911. Lime, the third item of importance, was valued at $758,739 in 1910 and at $695,662 in 1911.

The distribution of the mineral production of Massachusetts by substances in 1910 and 1911 was as follows:

*Mineral production of Massachusetts in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products, short tons | 1,922 | [a] $2,985 | | $1,707,413 | 1,187 | [a] $2,972 | | $1,700,287 |
| Coke, short tons | | | [a] [b] | [a] [b] | | | [a] [b] | [a] [b] |
| Emery, do | [b] | [b] | | | [b] | [b] | | |
| Feldspar, do | [b] | [b] | | | | | | |
| Fullers' earth, do | [b] | [b] | | | [b] | [b] | | |
| Gems and precious stones | | | | 280 | | | | 850 |
| Infusorial earth | | | | [b] | | | | [b] |
| Iron ore, long tons | [b] | [b] | | | [b] | [b] | | |
| Iron, pig, do | | | [a] [b] | [a] [b] | | | [a] [b] | [a] [b] |
| Lime, short tons | | | 140,942 | 758,739 | | | 137,440 | 695,662 |
| Mica | | | | [b] | | | | |
| Mineral waters, gallons sold | 4,691,159 | 241,949 | | | 4,610,474 | 218,870 | | |
| Pyrite, long tons | [b] | [b] | | | [b] | [b] | | |
| Quartz, short tons | [b] | [b] | | | [b] | [b] | | |
| Sand and gravel, short tons | 321,860 | 212,716 | | | 374,326 | 222,822 | | |
| Sand-lime brick | | | | | | | | [b] |
| Stone | | [c] | | [c] 2,870,640 | | [c] | | [c] 3,691,747 |
| Talc and soapstone, short tons | | | 7,475 | 52,204 | [c] | [c] | [c] 7,642 | [c] 36,883 |
| Miscellaneous | | 59,690 | | 1,475,109 | | 51,441 | | 1,521,341 |
| Total value, eliminating duplications | $5,903,976 | | | | $6,623,077 | | | |

[a] Value not included in total value.
[b] Value included under "Miscellaneous."
[c] Derived product includes raw product.

## MICHIGAN.

Michigan ranks second among the States in the production of iron ore, being exceeded by Minnesota; first in the production of salt, with New York second; second in the production of grindstones, with Ohio first. Michigan outranks all the other States in the production of sand-lime brick, ranks third in the production of copper, and fourth in the production of gypsum. With iron ore as the basis of iron production, Michigan ranks sixth among the States in the value of mineral output, which for Michigan in 1910 amounted to $83,581,377 and in 1911 to $65,077,232. Of these totals, the iron-ore production represented $41,393,585 in 1910 and $23,808,935 in 1911, the slump in the iron trade in 1911 being exhibited in Michigan

by a decrease in ore production of 4,359,513 long tons, or 32.77 per cent, in quantity, and of $17,584,650, or 42.48 per cent, in value. The iron ores of Michigan, as of the other two States included in the Lake Superior region (Minnesota and Wisconsin), are hematites of Bessemer grade. They occur in the Marquette range, all of which is in Michigan, and the Menominee and Gogebic ranges, the larger portions of which are in Michigan and smaller portions in Wisconsin. The principal producing counties are Marquette, Iron, Gogebic, and Dickinson; a relatively small quantity comes from Baraga County.

In 1882, the first year for which the volume of Mineral Resources was published, the Marquette and Menominee ranges were the only ones opened in the Lake Superior region. The production in that year was a little short of 3,000,000 long tons, most of which was from Michigan. The Crystal Falls and Iron River ranges began production in 1882, the first year covered by this review. These ranges are not as important producers as the better known ranges, but each one is still turning out over a million tons yearly. The Gogebic range was opened in 1884, as was the Vermillion range in Minnesota. The Mesabi range in Minnesota, now the greatest iron producer of the world, was opened in 1892, but Michigan continued to lead in the production of ore until the first year of the present century, its supremacy ceasing with 1900. At the present time two-thirds of the iron-ore production of the Lake Superior region is from the Mesabi range in Minnesota. A special chapter on the iron-ore reserves of Michigan, by C. K. Leith, is published in the present volume of Mineral Resources.

Next to iron ore in the value of Michigan's mineral production is copper, this metal furnishing nearly 34 per cent of the total value in 1910 and 42 per cent in 1911. Out of a total production of 1,097,232,749 pounds of copper, valued at $137,154,092 for the United States in 1911, Michigan produced 218,185,236 pounds, valued at $27,273,155. In 1910 Michigan produced 221,462,984 pounds out of a total of 1,080,159,509 pounds. "Lake" copper, as the output of Michigan is called, is largely native and is considered for some purposes superior to "electrolytic" copper. It usually sells about one-fourth cent a pound above other coppers. The mining of copper in Michigan is of prehistoric origin, the metal being used by the North American Indians before the advent of white men. Records since 1810 show that the total production of copper from that date to the close of 1911 has amounted to approximately 5,000,000,000 pounds, or about 30 per cent of the total output of the United States. The annual production at the present time is about four times what it was in 1882.

Michigan stands well up among the States in the manufacture of cement, the production amounting to 3,686,716 barrels in 1911 and 3,687,719 barrels in 1910. There were 11 cement mills in operation in 1911, all but one of them in the southern half of the Lower Peninsula. In the production of salt Michigan and New York have frequently alternated as first in rank, Michigan holding the place of honor in 1911. The salt works were formerly by-plants of the lumber industry, and used the sawmill waste for fuel. The decline in the lumber industry and the scarcity of wood for fuel has probably caused the salt works to turn to coal as a fuel and has influenced the coal production of the State. Up to 1896 the highest production of

coal had been made in 1882, with a total of 135,339 tons. Active development of Michigan coal began in 1897, and by 1901 the production had reached nearly 1,250,000 tons. At the present time it usually ranges from 1,500,000 to 2,000,000 tons, though the output in 1911 was a little below the smaller figure. Competition of higher grade coals from Pennsylvania holds back the production from the Michigan mines. Bay and Saginaw counties are the principal producers of both coal and salt.

There are two plants of by-product coke ovens, one at Delray and the other at Wyandotte, but the coal at both of these plants is drawn from mines of West Virginia. The mineral production of Michigan during 1910 and 1911, as far as the same can be shown, was as follows:

*Mineral production of Michigan in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Briquets, fuel, short tons | ..... | ..... | (a) | (a) | ..... | ..... | (b) (c) | (b) (c) |
| Bromine...pounds | ..... | ..... | (c) | (c) | ..... | ..... | (c) | (c) |
| Calcium chloride, short tons | ..... | ..... | (c) | (c) | ..... | ..... | (c) | (c) |
| Cement....barrels | ..... | ..... | 3,687,719 | $3,378,940 | ..... | ..... | 3,686,716 | $3,024,676 |
| Clay products, short tons | 1,424 | b $4,394 | ..... | 2,196,222 | 1,764 | b $5,272 | ..... | 2,083,932 |
| Coal....short tons | 1,534,967 | 2,930,771 | ..... | ..... | 1,476,074 | 2,791,461 | ..... | ..... |
| Coke....do | ..... | ..... | (b) (c) | (b) (c) | ..... | ..... | (b) (c) | (b) (c) |
| Copper....pounds | ..... | ..... | 221,462,984 | 28,125,799 | ..... | ..... | 218,185,236 | 27,273,155 |
| Gems and precious stones | ..... | ..... | ..... | 2,500 | ..... | ..... | ..... | 4,292 |
| Graphite, amorphous, short tons | (c) | (c) | ..... | ..... | (c) | (c) | ..... | ..... |
| Grindstones | ..... | ..... | ..... | (c) | ..... | ..... | ..... | 153,292 |
| Gypsum, short tons | 357,174 | ..... | ..... | 668,201 | 347,296 | ..... | ..... | 573,926 |
| Iron ore..long tons | 13,303,906 | 41,393,585 | ..... | ..... | 8,944,393 | 23,808,935 | ..... | ..... |
| Iron, pig.....do | ..... | ..... | 307,975 | b5,119,074 | ..... | ..... | 304,654 | b4,672,799 |
| Lime....short tons | ..... | ..... | 72,345 | 303,377 | ..... | ..... | 80,709 | 352,608 |
| Manganiferous ore, long tons | d 285,372 | (d) | ..... | ..... | (d) | (d) | ..... | ..... |
| Mineral paints, natural pigments, short tons | ..... | ..... | (c) | (c) | ..... | ..... | (c) | (c) |
| Mineral waters, gallons sold | 1,454,020 | 69,538 | ..... | ..... | 1,713,401 | 72,253 | ..... | ..... |
| Natural gas | ..... | 820 | ..... | ..... | ..... | 1,330 | ..... | ..... |
| Petroleum..barrels | (c) | (c) | ..... | ..... | (c) | (c) | ..... | ..... |
| Quartz..short tons | (c) | (c) | ..... | ..... | (c) | (c) | ..... | ..... |
| Salt.....barrels | 247,582 | 79,226 | 9,204,440 | 2,152,036 | 553,664 | 177,172 | 9,766,410 | 2,455,983 |
| Sand and gravel, short tons | 2,862,738 | 816,337 | ..... | ..... | 2,185,165 | 565,969 | ..... | ..... |
| Sand-lime brick | ..... | ..... | ..... | 240,649 | ..... | ..... | ..... | 210,001 |
| Scythestones | ..... | ..... | ..... | (c) | ..... | ..... | ..... | (c) |
| Silver, fine ounces (troy) | ..... | ..... | 262,200 | 141,600 | ..... | ..... | 507,700 | 274,100 |
| Stone | ..... | (e) | ..... | e 894,409 | ..... | (e) | ..... | e1,065,520 |
| Miscellaneous | ..... | 31,104 | ..... | 1,584,226 | ..... | 34,420 | ..... | 1,524,754 |
| Total value, eliminating duplications | $83,581,377 | | | | $65,077,232 | | | |

a No report for 1910.
b Value not included in total value.
c Value included under "Miscellaneous."
d Tonnage and value included with iron ore.
e Derived product includes stone sold rough.

The clay products of Michigan are valued at about $2,000,000 annually. The principal clay products are common brick and drain tile, and the leading counties are Wayne, Eaton, Jackson, and Saginaw.

Publication No. 8 of the Michigan Geological and Biological Survey, now in press, contains extended chapters on the occurrence, production, mining methods, and trade conditions of iron, copper, coal, salt, cement, and gypsum in the State.

Michigan leads all the other States in the manufacture of sand-lime brick. The production of 1910 was valued at $240,649, and that of 1911 at $210,001. Michigan also leads in the production of bromine, a by-product of salt manufacture. In addition to the products enumerated above, Michigan is also a producer of lime, mineral waters, building stone, graphite, grindstones, mineral paints, natural gas, oilstones, pig iron, petroleum, quartz, sand, and gravel. It is also a producer of silver as a by-product from copper mining.

### MINNESOTA.

Minnesota's wealth of iron ore gives it prominent place among the mining States, and the production of iron ore is the only important branch of the mining industry in the State. In its output of iron ore Minnesota far outranks all other States, the production of Minnesota in the last two years, in both quantity and value, being considerably more than one-half that of the United States. In 1910 the total production of iron ore in the United States was 56,889,734 long tons, valued at $140,735,607, of which Minnesota produced 31,966,769 long tons, valued at $78,462,560. The iron mining and manufacturing interests experienced a monopoly of hard times and business depression in 1911 and the production of iron ore fell off sharply in sympathy with the decline in the manufacture of pig iron and of steel. The total production of iron ore in the United States decreased in 1911 to 40,989,808 tons, valued at $86,419,830, and the output in Minnesota fell off to 23,398,406 long tons, valued at $48,447,760, the State maintaining its relative proportion of the tonnage. In 1910 Minnesota was credited with 56.2 per cent of the total quantity and 55.75 per cent of the total value; in 1911 it contributed 57.08 per cent of the quantity and 56.06 per cent of the value. The iron-ore production of Minnesota represents 96 per cent of the total value of its mineral products. With pig iron as a basis of production, Minnesota ranks thirty-eighth among the States. With iron ore as the basis of production, Minnesota advances to the seventh place in the list of mining States, with its production in 1910 valued at $83,868,520 and in 1911 at $53,460,561. By far the largest part of the iron production is from the Mesabi iron range, now the most important iron-producing district of the world. The Mesabi is the youngest of the great iron-ore ranges, having been opened in 1892 with a production in that year of less than 30,000 tons; by 1894 it had reached nearly 2,000,000 tons annually, and in 1902, when 10 years of age, it produced over 13,000,000 tons, or nearly one-half of the total output of Lake Superior iron ore. Its maximum output of 30,576,409 tons was attained in 1910. It dropped to 22,160,101 long tons in 1911. The Vermilion Range, one of the older producing districts, is also entirely within Minnesota. Its maximum production was attained in 1902—a total of 2,057,532 tons. The production of the Vermilion Range has shown a declining tendency in the last 10 years, the output of 1911 being only a little more than one-half of what it was in 1902. During 1911 a new range, known as the Cuyuna, was opened in Minnesota,

and the shipments made from this range in this year amounted to 147,431 tons. The iron-ore production of Minnesota is primarily the output of St. Louis County, whose production approximates 75 per cent of the total. Itasca County continues to produce approximately 25 per cent of the total, and smaller quantities come from Crow Wing and Lake counties.

Exclusive of the iron-ore and pig-iron production the value of the mineral products of Minnesota amounted to $5,405,960 in 1910 and to $5,012,801 in 1911. The pig iron produced in 1910 was valued at approximately $960,000 and in 1911 at a little less than $800,000. Among the less important mineral products are those from the quarries and clay pits. These two approximately divided the honor for second and third place in the State's mining industry.

In 1910 the value of the stone production in Minnesota was $1,976,095 and the value of the clay production was $1,901,296. In 1911 the quarry products were valued at $1,702,525 and the clay products at $1,693,478. The principal stone products are granite, limestone, and sandstone. The counties producing limestone are Blue Earth, Hennepin, Le Sueur, and Winona. Those producing sandstone are Nicollet, Pine, and Pipestone. Those producing granite are Benton, St. Louis, Sherburne, and Stearns. Minnesota ranks second among the States in the production of sand-lime brick. The total output in 1910 was valued at $154,250 and in 1911 at $93,734. Other products are sand and gravel, mineral waters, lime, cement, and pottery. A few gems also have been found within the State.

The distribution of the mineral products of Minnesota by substances in 1910 and 1911 was as follows:

*Mineral production of Minnesota in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Cement.....barrels | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Clay products, short tons | (b) | (a) (b) | ..... | c $1,901,296 | ..... | ..... | ..... | c $1,693,478 |
| Coke.....short tons | ..... | ..... | (a) (b) | (a) (b) | ..... | ..... | (a) (b) | (a) (b) |
| Feldspar.....do | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Gems and precious stones | ..... | ..... | ..... | 160 | ..... | ..... | ..... | ..... |
| Gypsum, short tons | ..... | ..... | ..... | ..... | ..... | ..... | ..... | (d) |
| Iron ore...long tons | 31,966,769 | $78,462,560 | ..... | ..... | 23,398,406 | $48,447,760 | ..... | ..... |
| Iron, pig.....do | ..... | ..... | b 58,244 | b 959,279 | ..... | ..... | b 56,668 | b 790,827 |
| Lime.....short tons | ..... | ..... | 45,194 | 289,227 | ..... | ..... | 39,208 | 242,945 |
| Mineral waters, gallons sold | 9,962,370 | 281,009 | ..... | ..... | 8,703,319 | 270,039 | ..... | ..... |
| Sand and gravel, short tons | 1,938,112 | 347,138 | ..... | ..... | 1,522,295 | 399,980 | ..... | ..... |
| Sand-lime brick | ..... | ..... | ..... | 154,250 | ..... | ..... | ..... | 93,734 |
| Stone | ..... | (e) | ..... | e 1,976,095 | ..... | (e) | ..... | e 1,702,525 |
| Miscellaneous | ..... | (e) | ..... | e 724,280 | ..... | (e) | ..... | e 973,004 |
| Total value, eliminating duplications | $83,868,520 | | | | $53,460,561 | | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of pottery, which is included under "Miscellaneous."
d Not mined, but calcined, in Minnesota. Value included under "Miscellaneous."
e Derived product includes raw product.

## MISSISSIPPI.

The only title of Mississippi to inclusion in the list of mining States rests in the utilization of some of its clays, in the digging of sand, chiefly for building purposes, and gravel, and in the sale of mineral waters. The total value of the mineral products of Mississippi in 1910 was $840,152, of which $632,999 was represented by the value of the clay products, $159,482 by sand and gravel, and $43,975 by the mineral waters sold. In 1911 the clay products were valued at $687,836, the sand and gravel at $286,206, and mineral waters at $75,050, the total value, including a few miscellaneous products, being $1,052,842. Eighty per cent of the value of the clay products is represented by common brick, the remainder being made up of drain tile and front brick. The pottery branch of the clay-working industry has been developed to some extent and wares to the value of about $20,000 are produced annually.

The statistics of production during the last two years have been as follows:

*Mineral production of Mississippi in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products, short tons | (a) (b) | (a) (b) | ..... | $632,999 | ..... | ..... | ..... | $687,836 |
| Iron ore...long tons | ..... | ..... | ..... | ..... | (b) | (b) | ..... | ..... |
| Mineral waters, gallons sold | 309,450 | $43,975 | ..... | ..... | 346,500 | $75,050 | ..... | ..... |
| Sand and gravel, short tons | 363,121 | 159,482 | ..... | ..... | 631,084 | 286,206 | ..... | ..... |
| Sand-lime brick | ..... | ..... | ..... | (b) | ..... | ..... | ..... | (b) |
| Miscellaneous | ..... | (c) | ..... | c3,701 | ..... | (c) | ..... | c3,750 |
| Total value, eliminating duplications | $840,152 | | | | $1,052,842 | | | |

a Value not included in total value.
b Value included under "Miscellaneous."
c Derived product includes raw product.

## MISSOURI.

Missouri leads all the other States in the production of four mineral substances, namely, zinc, lead, barytes, and tripoli. It is found in the production of mineral paints, fifth in lime and sand and gravel, sixth in Portland cement, and seventh in clay products. The principal products of the State are spelter (zinc) and lead. The production of spelter in 1910 was 140,652 short tons, valued at $15,190,416, and in 1911, 127,540 tons, valued at $14,539,560. The value of the lead product was less than that of spelter in 1910, but took first place in 1911, the production in 1910 being 161,659 short tons, valued at $14,225,992, and in 1911, 182,207 tons, valued at $16,398,630. The lead and spelter production constitutes 60 per cent of the State's total value in mineral products. Missouri furnishes 55 per cent of the total spelter product of the United States, and from 40 to 45 per cent of the total lead. The lead ores of Mis-

souri and the other States of the Mississippi Valley are almost free from silver, and the lead produced from them is known to the trade as "soft lead."

The principal producing counties of lead and zinc ores are St. Francois and Jasper.

Coal mining in Missouri has not shown much progress in recent years, although this State ranks first in priority of coal production in the States west of the Mississippi River, the census of 1840 showing a production of 9,972 short tons in that year. The maximum production was attained in 1903, when 4,238,586 tons were mined. Since then the industry has shown a declining tendency, the production in 1910 being 2,982,433 short tons, and in 1911, 3,760,607 tons. The smaller production in 1910, the smallest in 13 years, was due to the prolonged miners' strike in that year Competition with the more cheaply mined coal of Illinois, and in the last few years with petroleum and natural gas from the Mid-Continent field of Oklahoma and Kansas, has kept back production from the Missouri mines. The principal coal-producing counties are Macon, Lafayette, Adair, Ray, and Barton.

Fourth in importance in Missouri's mineral production are the clay-working industries, which contributed $7,087,766 in 1910 and $6,274,353 in 1911. The principal clay product is fire brick, and the fire brick region is in the immediate vicinity of St. Louis. In the value of its fire brick product Missouri ranks second among the States, being exceeded only by Pennsylvania, though Ohio also exceeds Missouri in the quantity of fire brick produced. The average value per thousand of the fire brick produced in Missouri was $20.28 in 1911, and that of Ohio's product was $16.46 per thousand. The total value of Missouri's clay products in 1911 was $6,274,353, of which fire brick furnished $1,763,548, common brick $1,309,164, sewer pipe $1,156,626, vitrified brick $488,299, and front brick $330,332. Drain tile and fireproofing are also important products, and, in fact, Missouri contributes something to most of the varied products from clay.

Missouri's production of Portland cement amounted to 4,114,859 barrels, valued at $3,349,312, in 1911, against 4,455,589 barrels, valued at $3,858,088, in 1910. The cement plants are located near St. Louis and Kansas City and at Hannibal and Cape Girardeau, all but the one near Kansas City being along the Mississippi River in the eastern part of the State.

The principal quarry product of Missouri is limestone, the value of this product in 1910 being $2,360,604 out of a total value for all stone of $2,520,665, and in 1911 $2,179,767 out of a total value of $2,338,585. Granite and sandstone are also produced in the State. The leading counties in the production of limestone are Jasper, Cape Girardeau, Greene, Jackson, Marion, St. Louis, and St. Louis City.

The production of lime amounted to 158,368 short tons, valued at $722,563, in 1911, against 179,550 tons, valued at $846,123, in 1910.

The less important mineral products of Missouri are barytes, copper, gems (occasionally), tripoli, mineral paints, mineral waters, natural gas, petroleum, iron ores, pyrite, sublimed lead, silver, sand, and gravel.

The total value of the mineral products of Missouri in 1910 was $51,857,640 and in 1911 $52,636,348.

The distribution of the mineral production of Missouri, by substances, in 1910 and 1911 was as follows:

*Mineral production of Missouri in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity | Value. | Quantity. | Value. |
| Barytes..short tons.. | 22,978 | $75,598 | ..... | ..... | 21,500 | $81,380 | ..... | ..... |
| Briquets, fuel..do.... | ..... | ..... | (a) | (a) | ..... | ..... | (b) (d) | (b) (d) |
| Cement.....barrels.. | ..... | ..... | 4,455,589 | $3,858,088 | ..... | ..... | 4,114,859 | $3,349,312 |
| Clay products, short tons..... | 287,445 | b 509,433 | ..... | 7,087,766 | 227,691 | b 512,088 | ..... | 6,274,353 |
| Coal.....short tons.. | 2,982,433 | 5,328,285 | ..... | ..... | 3,760,607 | 6,431,066 | ..... | ..... |
| Copper.....pounds.. | ..... | ..... | 94,452 | 11,995 | ..... | ..... | 640,411 | 80,051 |
| Gems and precious stones..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 25 |
| Gypsum..short tons.. | ..... | ..... | ..... | ..... | ..... | ..... | ..... | (c) |
| Iron ore...long tons.. | 78,341 | 168,697 | ..... | ..... | 72,788 | 153,676 | ..... | ..... |
| Iron, pig.....do.... | ..... | ..... | b 55,536 | b1,014,213 | ..... | ..... | b 66,665 | b1,108,940 |
| Lead.....short tons.. | ..... | ..... | 161,659 | 14,225,992 | ..... | ..... | 182,207 | 16,398,630 |
| Lime.....do.... | ..... | ..... | 179,550 | 846,123 | ..... | ..... | 158,368 | 722,563 |
| Mineral paints, natural pigments, short tons..... | ..... | ..... | (d) | (d) | ..... | ..... | (d) | (d) |
| Zinc-lead pigments, short tons..... | ..... | ..... | (d) | (d) | ..... | ..... | (d) | (d) |
| Mineral waters, gallons sold..... | 657,035 | 96,488 | ..... | ..... | 542,892 | 86,747 | ..... | ..... |
| Natural gas..... | ..... | 12,611 | ..... | ..... | ..... | 10,496 | ..... | ..... |
| Petroleum...barrels.. | (d) | (d) | ..... | ..... | (d) | (d) | ..... | ..... |
| Pyrite....long tons.. | ..... | ..... | ..... | ..... | (d) | (d) | ..... | ..... |
| Sand and gravel, short tons..... | 6,108,460 | 1,339,519 | ..... | ..... | 3,605,913 | 1,042,674 | ..... | ..... |
| Silver, fine ounces (troy)..... | ..... | ..... | 32,200 | 17,400 | ..... | ..... | 49,100 | 26,500 |
| Stone..... | ..... | 725,922 | ..... | 1,794,743 | ..... | (e) | ..... | e2,338,585 |
| Tripoli..... | ..... | ..... | ..... | 71,978 | ..... | ..... | ..... | (d) |
| Zinc.....short tons.. | ..... | ..... | 140,652 | 15,190,416 | ..... | ..... | 127,540 | 14,539,560 |
| Miscellaneous..... | ..... | (e) | ..... | e1,006,019 | ..... | 9,795 | ..... | 1,144,500 |
| Total value, eliminating duplications.. | $51,857,640 | | | | $52,636,348 | | | |

a No report for 1910.
b Value not included in total value.
c Not mined, but calcined, in Missouri. Value included under "Miscellaneous."
d Value included under "Miscellaneous."
e Derived product includes raw product.

## MONTANA.

Montana ranks eighth among the States in the value of its mineral production, the chief industry being the mining and smelting of copper ores. In the production of copper Montana holds second place, with Arizona first. Montana's output of copper in 1911 was 271,814,491 pounds, valued at $33,976,811 against 283,078,473 pounds, valued at $35,950,966 in 1910. The total value of the mineral products was $53,454,926 in 1911, and $54,388,119 in 1910, so that the value of the copper output approximates 70 per cent of the total. As is well known, the center of the copper mining industry of Montana is in and around the city of Butte, with less important camps scattered through the southwestern part of the State. The reduction works are at Butte, Anaconda, and Great Falls. A small quantity of copper was produced in Montana as early as 1868, but it was not until 1882, the first year for which the volume of Mineral

Resources was published, that the industry began to assume importance. In 1881 the production was less than 1,500,000 pounds. It rose to over 9,000,000 pounds in 1882. By 1887 it had reached 78,699,677 pounds, and Montana outranked Michigan, holding the premiership, except in one year (1891) until superseded by Arizona in 1907, 20 years later. Once since then (in 1909) Montana again held first place. Montana's total production of copper to the close of 1911 has amounted to 5,598,253,884 pounds, somewhat more than one-third the total production of the United States. Montana also ranks second in the production of silver, with Nevada in first place by a small majority—less than 1 per cent. Montana's production of silver was 12,282,900 fine ounces, valued at $6,632,700, in 1910 and 12,163,900 ounces, valued at $6,568,500, in 1911. Most of the silver is obtained in the refining of copper.

The statistics of production in Montana in 1910 and 1911 are given in the following table:

*Mineral production of Montana in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Cement.....barrels. | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Clay products, short tons. | 7,011 | b $10,069 | ..... | c $411,824 | 4,912 | b $9,617 | ..... | c $260,547 |
| Coal.....do. | 2,920,970 | 5,329,322 | ..... | ..... | 2,976,358 | 5,342,168 | ..... | ..... |
| Coke.....do. | ..... | ..... | (a) (b) | (a) (b) | ..... | ..... | ..... | ..... |
| Copper.....pounds. | ..... | ..... | 283,078,473 | 35,950,966 | ..... | ..... | 271,814,491 | 33,976,811 |
| Gems and precious stones. | ..... | ..... | ..... | 57,923 | ..... | ..... | ..... | 221,613 |
| Gold, fine ounces (troy). | ..... | ..... | 179,975 | 3,720,400 | ..... | ..... | 176,554 | 3,649,700 |
| Grindstones. | ..... | ..... | ..... | ..... | ..... | ..... | ..... | (a) |
| Gypsum..short tons. | (a) | ..... | ..... | (a) | (a) | ..... | ..... | (a) |
| Lead.....do. | ..... | ..... | 1,790 | 157,520 | ..... | ..... | 2,499 | 224,910 |
| Lime.....do. | ..... | ..... | 4,480 | 26,925 | ..... | ..... | 3,100 | 18,480 |
| Mineral waters, gallons sold. | (a) | (a) | ..... | ..... | 74,750 | 5,988 | ..... | ..... |
| Sand and gravel, short tons. | (a) | (a) | ..... | ..... | 5,143 | 2,461 | ..... | ..... |
| Sand-lime brick. | ..... | ..... | ..... | (a) | ..... | ..... | ..... | ..... |
| Silver, fine ounces (troy). | ..... | ..... | 12,282,900 | 6,632,700 | ..... | ..... | 12,163,900 | 6,568,500 |
| Stone. | ..... | (d) | ..... | d 452,755 | ..... | (d) | ..... | d 212,233 |
| Zinc.....short tons. | ..... | ..... | 12,408 | 1,340,064 | ..... | ..... | 22,115 | 2,521,110 |
| Miscellaneous. | ..... | 7,491 | ..... | 419,135 | ..... | ..... | ..... | 450,405 |
| Total value, eliminating duplications. | $54,388,119 | | | | $53,454,926 | | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Exclusive of pottery, which is included under "Miscellaneous."
d Derived product includes stone sold rough.

The first record of coal production in Montana is for 1880, when an output of 224 short tons was reported. The production did not exceed 1,000,000 tons until 1895, since when it has steadily progressed and in 1911 reached the maximum of 2,976,358 tons, valued at $5,342,168. The principal operations have been in Carbon and Cascade counties, but recent developments in the Bull Mountain field in Fergus and Musselshell counties, following the completion of the Chicago, Milwaukee & Puget Sound Railway, are bringing those counties prominently to the front.

In the production of gold (like silver, largely recovered from copper refining) Montana ranks seventh among the States with a production valued at $3,720,400 in 1910 and at $3,649,700 in 1911. Montana leads in the production of precious stones, this supremacy being due to the mining of sapphire, one of the few instances of gem mining conducted as an industry in the United States.

In the production of spelter, Montana holds fifth place, with a production in 1910 of 12,408 short tons, valued at $1,340,064, and in 1911 of 22,115 tons, valued at $2,521,110.

The other mineral products of Montana are arsenic, clay, lead, cement, grindstones, gypsum, lime, mineral waters, sand-lime brick, stone, sand, and gravel.

## NEBRASKA.

Nebraska has been termed "the State without a mine," but it has clay deposits that are utilized, sand and gravel pits, some stone quarries, and waters sold commercially. There are also deposits of volcanic ash or pumice, and in the production of the last mentioned Nebraska ranks first among the States. The value of the clay products in 1911 amounted to $795,894 out of a total $1,316,168, and in 1910 to $938,827 out of a total $1,552,794. The principal clay product is common brick. The other clay products made are vitrified brick, front brick, drain tile, and fireproofing. These clay resources have their greatest development in Douglas, Adams, Lancaster, and Dodge counties. Stone quarries, all of which are of limestone, are located in Cass and Gage counties. Most of the product is crushed for the manufacture of concrete. The total value of the limestone in 1910 was $338,731 and in 1911 $263,501. The production of sand and gravel amounted in 1910 to 1,076,602 short tons, valued at $168,255, and in 1911 to 858,288 tons, valued at $156,777. The sand production is used chiefly for building purposes. Although Nebraska ranks first in the production of pumice, the output may not be published separately, as there are less than three producers in the State. A small quantity of sand-lime brick is manufactured in Fremont County.

The statistics of mineral production in Nebraska in 1910 and 1911 are given in the following table:

*Mineral production of Nebraska in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products | | | | $938,827 | | | | $795,894 |
| Mineral waters, gallons sold | 12,785 | $1,529 | | | 21,641 | $1,925 | | |
| Pumice..short tons.. | (a) | (a) | | | (a) | (a) | | |
| Sand and gravel, short tons | 1,076,602 | 168,255 | | | 858,288 | 156,777 | | |
| Sand-lime brick | | | | (a) | | | | (a) |
| Stone | | 50,547 | | 288,184 | | (b) | | b 263,501 |
| Miscellaneous | | (b) | | b 105,452 | | (b) | | b 98,071 |
| Total value, estimating duplications | $1,552,794 | | | | $1,316,168 | | | |

a Value included under "Miscellaneous." b Derived product includes raw product.

## NEVADA.

In the glory days of the famous Comstock lode and before the active days of Leadville, Cripple Creek, the Homestake, and other great western camps—before the days of the Yukon and Alaska—Nevada was relatively more important as a mining State than it is to-day. But although the glamor of the Comstock days has departed, the mining industry has by no means ceased to exist, and at the present time Nevada ranks sixteenth among the States in the value of its mineral production. It still ranks first in the production of silver, though reduced as compared with the annual output from 1873 to 1878, when the Comstock lode, the greatest silver-producing deposit the world has known, was yielding from 10,000,000 to 17,000,000 ounces of silver a year. In addition to being now, as then, the premier silver-producing State, Nevada holds third place in rank as a producer of gold, the yellow metal coming mainly from the Goldfield district, in Esmeralda County, first productive in 1903; the Tonopah district, in Nye County, first productive in 1902; and the new National district, in Humboldt County. The gold production of Nevada in 1910 amounted to $18,873,700, and in 1911 to $18,096,900. By far the larger part of the production came from siliceous ores. The value of the silver production is approximately one-third that of gold, amounting to 12,366,000 fine ounces, valued at $6,677,600 in 1910, and to 13,185,900 ounces, valued at $7,120,400, in 1911. Of the total production the Tonopah district in Nye County contributes about 90 per cent, mainly from siliceous ores. Mineral County ranks second, Storey County, the home of the Comstock, third, and Humboldt County fourth. The production from the Comstock was 320,716 fine ounces in 1910 and 618,000 ounces in 1911. The largest output from the Comstock was in 1876, when over 17,000,000 ounces were produced. This famous district was opened in 1860, ran a spectacular course for 20 years, and then began to decline. As shown above, it is now of little importance.

Although copper mining on an important scale did not begin in Nevada until 1908, the State now ranks fifth in the production of this metal. The Ely district in White Pine County is the only producer of any importance. In 1907, before the district was thoroughly developed, the copper production of the State was less than 2,000,000 pounds. In 1908 it was nearly 12,250,000 pounds; in 1909 it was nearly 54,000,000 pounds; in 1910 it was over 64,000,000 pounds, and in 1911 it was 65,561,015 pounds. In 1910 the total value of the mineral production of Nevada was $34,617,127, of which gold, silver, and copper made up $33,742,119; in 1911 the total production was valued at $34,148,101, of which the three metals constituted $33,412,427. The other mineral products of the State, none of which is of much importance compared with the three chief metals, are clay products, coal, precious stones, graphite, gypsum, infusorial earth, lime, lead, mineral waters, quicksilver, salt, sand, gravel, stone, sulphur, and zinc.

The following table shows the quantity and value of the mineral products of Nevada in 1910 and 1911:

*Mineral production of Nevada in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products | | | | (a) | | | | (a) |
| Coal.....short tons | | | | | (a) | (a) | | |
| Copper.....pounds | | | 64,494,640 | $8,190,819 | | | 65,561,015 | $8,195,127 |
| Gems and precious stones | | | | 49,210 | | | | 6,295 |
| Gold, fine ounces (troy) | | | 913,015 | 18,873,700 | | | 875,438 | 18,096,900 |
| Graphite, amorphous..short tons | (a) | (a) | | | (a) | (a) | | |
| Gypsum.....do | (a) | | | (a) | (a) | | | (a) |
| Infusorial earth | | | | | | | | (a) |
| Lead.....short tons | | | 2,195 | 193,160 | | | 1,083 | 97,470 |
| Lime.....do | | | | | | | (a) | (a) |
| Mineral waters, gallons sold | (a) | (a) | | | (a) | (a) | | |
| Quicksilver...flasks | | | 70 | 3,256 | | | (a) | (a) |
| Salt.....barrels | | | 17,535 | 10,600 | 2,606 | $2,405 | 10,250 | 14,547 |
| Sand and gravel, short tons | | | | | 223,510 | 33,591 | | |
| Silver, fine ounces (troy) | | | 12,366,000 | 6,677,600 | | | 13,185,900 | 7,120,400 |
| Stone | | | | (a) | | | | (a) |
| Sulphur...long tons | (a) | (a) | | | | | | |
| Tungsten ore (60 per cent concentrates), short tons | | | | | | | (a) | (a) |
| Zinc.....do | | | 1,516 | 163,728 | | | 1,595 | 181,830 |
| Miscellaneous | | $12,150 | | 442,904 | | 10,527 | | 378,482 |
| Total value, eliminating duplications | $34,617,127 | | | | $34,148,101 | | | |

a Value included under "Miscellaneous."

## NEW HAMPSHIRE.

The principal mineral product of New Hampshire is granite, the value of which ($1,239,656 in 1910 and $1,017,272 in 1911) represents more than one-half the total value of all the mineral production of the State. The principal quarrying operations are in Carroll, Cheshire, Hillsboro, and Merrimack counties. The granite is used chiefly for building purposes and for monumental work.

The manufacture of common brick is the only use made of the clay resources of the State. This industry, which contributes 25 per cent of the total value of mineral products, is located chiefly in Strafford, Rockingham, and Merrimack counties. Ten per cent of the total value is derived from the sale of mineral waters.

The less important mineral products are copper, fluorspar, garnet, gems (occasionally), gold, mica, silver, and scythestones.

The following table shows the mineral production of New Hampshire in 1910 and 1911:

*Mineral production of New Hampshire in 1910 and 1911.*

| Product | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products | | | | [a] $566,121 | | | | [a] $430,748 |
| Copper.....pounds | | | 12,409 | 1,576 | | | | |
| Fluorspar.short tons | | | | | (b) | (b) | | |
| Garnet.....do | (b) | (b) | | | (b) | (b) | | |
| Gems and precious stones | | | | | | | | 20 |
| Gold, fine ounces (troy) | | | (b) | (b) | | | | |
| Mica | | | | (b) | | | | 44,927 |
| Mineral waters, gallons sold | 706,828 | $202,831 | | | 406,660 | $139,130 | | |
| Scythestones | | | | (b) | | | | (b) |
| Silver, fine ounces (troy) | | | (b) | (b) | | | | |
| Stone | | 179,984 | | 1,059,672 | | (c) | | [c] 1,017,272 |
| Miscellaneous | | (c) | | [c] 132,669 | | 24,708 | | 70,840 |
| Total value, eliminating duplications | $2,142,853 | | | | $1,727,645 | | | |

[a] Exclusive of pottery, which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Derived product includes raw product.

## NEW JERSEY.

New Jersey is the only State of any importance as a mineral producer in which the utilization of the clay resources constitutes the chief industry and in which the value of the clay products represents over 50 per cent of the total output of the State. The clay products of New Jersey include every variety of brick and tile, except vitrified brick, and every variety of pottery produced in the United States. The total value of the clay products in 1910 was $17,834,309, of which $9,245,854 represented the value of brick and tile and $8,588,455 the value of pottery. In 1911 the brick and tile products were valued at $9,776,287 and pottery at $8,401,941, the total value being $18,178,228. In the total value of its clay products New Jersey ranks third among the States, being exceeded by Ohio and Pennsylvania. In the value of the pottery produced New Jersey holds second place, Ohio being first. The principal brick and tile products are common brick, architectural terra cotta, fireproofing, tile (not drain), fire brick, and front brick, and the leading producing counties are Mercer, Middlesex, Bergen, and Camden. The chief center of the pottery industry is at Trenton. Second to clay working is the manufacture of Portland cement, the plants in the vicinity of Phillipsburg being the eastern end of the celebrated Lehigh district of Pennsylnia. The production of cement in 1911 amounted to 4,411,890 barrels, valued at $3,259,528, against 4,184,698 barrels, valued at $3,067,265, in 1910.

New Jersey ranks third among the States in the production of spelter and is the most important among the Eastern States. The zinc-producing region is the famous Franklin Furnace district in Sussex County, the most northerly county in the State. Mining has been carried on in this region continuously for over 60 years. The production of spelter in New Jersey was 20,217 short tons, valued at $2,183,436, in 1910, and 15,128 tons valued at $1,724,592, in 1911.

The principal quarry product of New Jersey is trap rock, produced in the Palisades region (Bergen, Essex, Hudson, Hunterdon, Morris, Somerset, and Union counties) and used chiefly for road making and railroad ballast. The total value of all stone quarried in New Jersey in 1910 was $1,675,174, of which $1,257,712 was the value of the trap rock produced. The total value of all stone produced in 1911 was $1,597,410, of which $1,136,385 was represented by trap rock. Limestone to the value of $224,707 in 1910 and of $138,148 in 1911 was quarried in Hunterdon, Sussex, and Warren counties. Sandstone is produced in Bergen, Hunterdon, and Mercer counties.

New Jersey is one of the leading producers of molding sand, the output in 1910 amounting to 679,191 short tons, valued at $436,460, and in 1911 to 715,654 short tons, valued at $392,840. The total value of all sand and gravel produced in 1910 was $1,139,275 and in 1911, $1,058,926. Other products of the State are pig iron, iron ore, occasional gems, lime, mineral waters, sand-lime brick, slate, slate pigments, soapstone, and zinc oxide.

The total value of the mineral products of New Jersey in 1910 was $28,266,383 and in 1911, $27,559,246, distributed as follows:

*Mineral production of New Jersey in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Briquets, fuel, short tons | | | [a] | [a] | | | [b] [c] | [b] [c] |
| Cement.....barrels | | | 4,184,698 | $3,067,265 | | | 4,411,890 | $3,259,528 |
| Clay products, short tons | 405,591 | [b] $657,805 | | 17,834,309 | 405,912 | [b] $658,875 | | 18,178,228 |
| Coke.....short tons | | | [b] [c] | [b] [c] | | | [b] [c] | [b] [c] |
| Gems and precious stones | | | | 500 | | | | 350 |
| Iron ore...long tons | 521,832 | 1,582,213 | | | 359,721 | 1,158,271 | | |
| Iron, pig.....do | | | 239,221 | [b] 3,797,656 | | | [b] 41,835 | [b] 583,300 |
| Lime.....short tons | | | 34,148 | 128,964 | | | 27,057 | 113,784 |
| Mineral paints, zinc-lead pigments, short tons | | | [c] | [c] | | | [c] | [c] |
| Mineral waters, gallons sold | 1,583,050 | 133,139 | | | 2,233,627 | 210,123 | | |
| Sand and gravel short tons | 2,962,815 | 1,139,275 | | | 3,352,765 | 1,058,926 | | |
| Sand-lime brick | | | | 23,811 | | | | 17,710 |
| Slate | | | | [c] | | | | [c] |
| Stone | | 270,473 | | 1,404,701 | | [d] | | [d] 1,597,410 |
| Talc.....short tons | | | [c] | [c] | | | [c] | [c] |
| Zinc.....do | | | 20,217 | 2,183,436 | | | 15,128 | 1,724,592 |
| Miscellaneous | | | | 1,158,004 | | | | 925,056 |
| Total value, eliminating duplications | $28,266,383 | | | | $27,559,246 | | | |

[a] No report for 1910.
[b] Value not included in total value.
[c] Value included in "Miscellaneous."
[d] Derived product includes stone sold rough.

## NEW MEXICO.

Two States included in the Rocky Mountain division lay more claim to recognition as mining States by reason of their production of coal than by their output of precious or semiprecious metals. One of the States is Wyoming, the other is the new State of New Mexico. The latter is not of much prominence as a mining State at the present time, the main support of the population being cattle raising and other forms of agriculture, New Mexico ranking eighth among the Rocky Mountain States in the value of its mineral output. In 1910 the total value of all the mineral produced in New Mexico was $7,902,036, of which the coal production represented $4,877,151, or 62 per cent; in 1911 the total value was $7,869,918 of which the coal mines contributed $4,525,925, or 58 per cent. The principal coal-mining operations are in the Raton-Trinidad district of Colfax County, and in the Gallup district of McKinley County (formerly a part of Bernalillo County). These two districts produce over 90 per cent of the coal output of the State. The Raton district produces a good grade of coking coal and extensive coking operations are carried on at Dawson, which may truthfully be described as a model coal mining camp both in the town itself and in the up-to-date character of the mining methods employed.

As already indicated, New Mexico makes little pretension to importance as a metal-mining State. One of the leading metal products is copper, valued in 1910 at $480,645 and in 1911 at $357,550. The principal production is from the Central and Lordsburg districts in Grant County. The gold production, most of which is from siliceous ores mined at Mogollon in Socorro County, was valued at $477,200 in 1910 and at $761,600 in 1911. The Mogollon district is also the chief producer of silver, of which the total production of the State was valued at $420,600 in 1910 and at $724,300 in 1911. The zinc production in the last two years exceeded the value of the copper output. The zinc-producing counties are Grant, Socorro, and Santa Fe, all of the product of Santa Fe County and part of that from Socorro County being from lead-zinc ores. The zinc product of the State was valued at $530,388 in 1910 and at $430,692 in 1911. The quarry products rank along with the several metals, the value of the stone produced in the last two years being $443,650 for 1910 and $406,454 for 1911. Limestone from Guadalupe, San Miguel, and Santa Fe counties constitutes 99 per cent of the stone production. It is used chiefly for railroad ballast. The other mineral products of the State are coke, fluorspar, gypsum, iron ore, lead, lime, mica, mineral waters, salt, vanadium minerals, turquoise and other gem materials, clay products, sand and gravel.

The following table shows the quantity and value of the mineral products of New Mexico in 1910 and 1911:

*Mineral production of New Mexico in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products, short tons | 14,235 | [a] $30,727 | ..... | [b] $129,275 | 8,514 | [a] $12,800 | ..... | [b] $174,651 |
| Coal.....short tons | 3,508,321 | 4,877,151 | ..... | ..... | 3,148,158 | 4,525,925 | ..... | ..... |
| Coke.....do | ..... | ..... | 401,646 | [a] 1,306,136 | ..... | ..... | 381,927 | [a] 1,240,963 |
| Copper.....pounds | ..... | ..... | 3,784,609 | 480,645 | ..... | ..... | 2,860,400 | 357,550 |
| Fluorspar.short tons | [c] | [c] | ..... | ..... | [c] | [c] | ..... | ..... |
| Gems and precious stones | ..... | ..... | ..... | 16,800 | ..... | ..... | ..... | 26,655 |
| Gold, fine ounces (troy) | ..... | ..... | 23,085 | 477,200 | ..... | ..... | 36,847 | 761,700 |
| Gypsum.short tons | [c] | ..... | ..... | [c] | [c] | ..... | ..... | [c] |
| Iron ore...long tons | 188,720 | 189,112 | ..... | ..... | 145,195 | 146,401 | ..... | ..... |
| Lead.....short tons | ..... | ..... | 1,731 | 152,328 | ..... | ..... | 1,381 | 124,290 |
| Lime.....do | ..... | ..... | 4,445 | 17,930 | ..... | ..... | 1,945 | 13,004 |
| Mica | ..... | ..... | ..... | [c] | ..... | ..... | ..... | [c] |
| Mineral waters, gallons sold | 171,600 | 30,160 | ..... | ..... | 226,333 | 41,833 | ..... | ..... |
| Salt.....barrels | ..... | ..... | [c] | [c] | ..... | ..... | [c] | [c] |
| Sand and gravel, short tons | 4,310 | 2,043 | ..... | ..... | 267,615 | 18,774 | ..... | ..... |
| Silver, fine ounces (troy) | ..... | ..... | 779,000 | 420,600 | ..... | ..... | 1,341,400 | 724,300 |
| Stone | ..... | [d] | ..... | [d] 443,650 | ..... | [d] | ..... | [d] 406,454 |
| Vanadium, short tons | ..... | ..... | ..... | ..... | ..... | ..... | [c] | [c] |
| Zinc.....short tons | ..... | ..... | 4,911 | 530,388 | ..... | ..... | 3,778 | 430,6929 |
| Miscellaneous | ..... | [d] | ..... | [d] 134,754 | ..... | [d] | ..... | [d] 117 68 |
| Total value, eliminating duplications | $7,902,036 | | | | $7,869,918 | | | |

[a] Value not included in total value.
[b] Exclusive of pottery, which is included under "Miscellaneous."
[c] Value included under "Miscellaneous."
[d] Derived product includes raw product.

## NEW YORK.

New York, first in the number of its inhabitants and first in the value of its manufactures, ranks thirteenth among the States in the value of its mineral output. It produces no coal and none of the precious and semiprecious metals. Its fuel production consists of petroleum and natural gas, valued approximately at $1,500,000 each. Only a small part of the latter is used for fuel in industrial enterprises. Practically all of the coal consumed in the State of New York is drawn from the anthracite and bituminous mines of Pennsylvania, which are within close proximity. Although New York is without any production of coal or metals (except iron) and ranks as low as thirteenth among the States, it is the premier producer of eight mineral products. The mineral substances in which New York ranks first in production are emery, abrasive garnet, graphite, gypsum, millstones, salt, fibrous talc, and natural cement. It is second in the production of mineral waters, sand and gravel, stone, and iron pyrite; third in the production of sand-lime brick; fourth in the production of iron ore, pig iron, feldspar, and infusorial earth. With pig iron as the basis of production, the total value of the mineral products of New York in 1910 was $73,799,494, of which pig iron constituted $31,693,623, and in 1911 the total value of the mineral products was $63,357,365, of which the value of the pig iron was $23,924,194, from which it appears that the value of the pig iron is from 40 to 45 per

cent of the total production. If the value of the pig-iron be deducted and that of the iron-ore production added, the total value of the mineral production of New York in 1910 was $45,954,554, and in 1911, $42,392,180. Of these the clay-working industries furnish the larger proportion, or about 25 per cent. The principal clay product is common brick, manufactured in the Hudson River region, embracing the counties of Albany, Columbia, Dutchess, Greene, Orange, Rensselaer, Rockland, Ulster, and Westchester, the largest brick-producing region in the world. New York contributes to all of the other brick and tile products, most important of which, next to common brick, is architectural terra cotta. The brick and tile products of the State were valued at $9,778,288 in 1910, and at $8,006,012 in 1911. The pottery products consist principally of porcelain electrical supplies and of delft and belleek ware. The total value of the pottery products in 1910 was $2,093,661, and in 1911 it was $2,178,364. The total value of the clay production in 1911 was $10,184,376, against $11,871,949 in 1910.

Next to the clay products those of the quarries represent the largest value of New York's total mineral production, and the utilization of these resources, which is chiefly for the building of permanent structures, is of sociological interest in that it bears witness to the development of desirable citizenship. The stone quarries of New York produced in 1910 stone valued at $6,410,688, and in 1911 at $6,895,466. The principal stone quarried is limestone, produced in Albany, Cayuga, Dutchess, Erie, Genesee, Madison, Montgomery, Niagara, Onondaga, Rockland, St. Lawrence, and Schoharie counties; sandstone is produced in Orleans, Broome, Ulster, Chenango, Delaware, and Wyoming counties; and trap rock is produced in Rockland County. Marble and granite are of less commercial importance. The iron-ore production of New York amounted in 1910 to 1,287,209 long tons, valued at $3,848,683, and in 1911 to 1,057,984 tons, valued at $2,959,009. The principal ore produced is magnetite from the vicinity of Port Henry on Lake Champlain. The cement production of New York in 1910 amounted to 3,296,350 barrels of Portland cement, valued at $2,906,551, and of 304,598 barrels of natural cement, valued at $150,952; in 1911 the production consisted of 3,314,217 barrels of Portland cement, valued at $2,669,194, and the combined production of natural cement in New York and Pennsylvania was 429,832 barrels, valued at $178,937. The manufacture of natural cement, which at one time was an important industry in New York, has been almost entirely displaced by Portland cement, of which a more uniform product can be made than is possible in the manufacture of natural cement. The location of the former important natural-cement industry was in the vicinity of Rockdale, and by far the larger portion of the natural cement produced in the United States was from this district. In 1882 the production of natural cement from Rockdale was 3,165,000 barrels. From 1891 to 1900 the average annual production was approximately 8,000,000 barrels. In 1903 the decline began and fell off rapidly, until in 1911, when the total production of natural cement in the United States was less than 1,000,000 barrels.

The gypsum products of the State in 1910 were valued at $1,153,977 and in 1911 at $1,199,596. This is one of the eight industries in which New York ranks first. The quantity of gypsum mined was 467,339

short tons in 1910 and 472,834 tons in 1911. The values as given above are for the production in the condition when first sold, whether the material was marketed crude, ground for land plaster, or calcined into plaster of Paris. When calcined the value of the calcined product is considered. The principal counties in the production of gypsum are Erie, Genesee, Monroe, and Onondaga. New York also leads in the production of salt, most of which is obtained from evaporation of brine in Onondaga, Livingston, Genesee, and Wyoming counties. The production in Onondaga County is obtained largely by solar evaporation from brines taken from the State reservation. The production in the other districts, of which Warsaw, in Wyoming County, is the most important, is obtained by artificial evaporation.

The following table shows the quantity and value of the mineral products of New York in 1910 and 1911:

*Mineral production of New York in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Abrasives, artificial, pounds | | | (a) (d) | (a) (d) | | | (a) (d) | (a) (d) |
| Aluminum .pounds | | | b47,734,000 | b$8,955,700 | | | b46,125,000 | b$8,084,000 |
| Briquets, fuel, short tons | | | (c) | (c) | | | 22,350 | a123,925 |
| Cement.....barrels | | | 3,600,948 | 3,057,503 | | | 3,601,789 | 2,812,440 |
| Clay products, short tons | 5,880 | a$13,241 | | 11,871,949 | 4,882 | a$10,308 | | 10,184,376 |
| Coke.....short tons | | | 652,459 | a2,635,873 | | | 686,172 | a2,883,990 |
| Emery.....do | (d) | (d) | | | (d) | (d) | | |
| Feldspar.....do | 12,412 | 47,864 | | | 18,800 | 79,926 | | |
| Ferro-alloys, long tons | | | (e) | (e) | | | (a) (d) | (a) (d) |
| Garnet, abrasive, short tons | (d) | (d) | | | (d) | (d) | | |
| Graphite, crystalline, pounds | 2,605,000 | 158,500 | | | 2,480,000 | 136,750 | | |
| Graphite, artificial, pounds | | | 13,149,100 | a945,000 | | | 10,144,000 | a644,000 |
| Gypsum .short tons | 467,339 | | | 1,153,977 | 472,834 | | | 1,199,596 |
| Infusorial earth | | | | (d) | | | | (d) |
| Iron ore...long tons | 1,287,209 | 3,848,683 | | | 1,057,984 | 2,959,009 | | |
| Iron, pig.....do | | | 1,895,018 | a31,693,623 | | | 1,537,201 | a23,924,194 |
| Lime.....short tons | | | 146,474 | 620,564 | | | 119,707 | 524,845 |
| Millstones | | | | 13,753 | | | | 13,335 |
| Mineral paints, natural pigments, short tons | | | 17,721 | 93,416 | | | 12,303 | 66,406 |
| Mineral waters, gallons sold | 8,780,903 | 858,635 | | | 10,245,261 | 939,003 | | |
| Natural gas | | 1,678,720 | | | | 1,418,767 | | |
| Petroleum...barrels | 1,053,838 | 1,414,668 | | | 952,515 | 1,248,950 | | |
| Pyrite.....long tons | (d) | (d) | | | (d) | (d) | | |
| Quartz...short tons | (d) | (d) | | | (d) | (d) | | |
| Salt.....barrels | (d) | (d) | (d) | (d) | (d) | (d) | (d) | (d) |
| Sand and gravel, short tons | 7,129,096 | 2,305,123 | | | 7,537,578 | 2,414,452 | | |
| Sand-lime brick | | | | 89,150 | | | | 95,930 |
| Slate | | | | 84,822 | | | | 120,359 |
| Stone | | 1,039,570 | | 5,371,118 | | (f) | | f6,895,466 |
| Talc, fibrous, short tons | | | 71,710 | 728,180 | | | 62,030 | 613,286 |
| Miscellaneous | | 1,187,468 | | 2,921,471 | | 1,208,189 | | 3,710,535 |
| Total value, eliminating duplications | $45,954,554 | | | | $42,392,180 | | | |

a Value not included in total value.
b Consumption.
c No report for 1910.
d Value included under "Miscellaneous."
e Not collected for 1910.
f Derived product includes stone sold rough.

The production of fibrous talc is practically a monopoly in New York. It is used in the manufacture of medium grades of paper, and is produced almost entirely at Gouverneur, in St. Lawrence County. Coke is made in by-product ovens at Tonawanda and at Syracuse from coal brought from Pennsylvania. The production of coke in 1911 was 686,172 short tons, valued at $2,883,990, against 652,459 tons, valued at $2,635,873, in 1910. The production of aluminum, obtained by electric smelting at Niagara Falls, is one of the industries in which New York leads, but the statistics of production may not be published without divulging confidential information.

In addition to the substances discussed above New York produces feldspar, emery abrasive garnet, graphite, lime, metallic paints and other pigments, millstones, sand-lime brick, slate, infusorial earth, pyrite, quartz, and sand and gravel.

## NORTH CAROLINA.

North Carolina leads in the production of mica and of monazite, and is second in the production of barytes. The principal industry, however, based upon the value of the products obtained, is clay working. The output of the kilns make approximately 50 per cent of the State's total production. The clay products are principally common brick, with small quantities of front brick, drain tile, etc. The pottery products are red, earthen, stone, yellow, and Rockingham ware. Second in importance among the mineral products in North Carolina is building stone, composed almost entirely of granite produced in Buncombe, Mecklenburg, Rockingham, Rowan, Surry, Vance, and Warren counties, with small amounts of sandstone, marble, and limestone. The total value of the stone produced in North Carolina in 1910 was $879,572, and in 1911 it was $826,928.

The production of mica, in which the State holds the premiership, was valued at $230,460 in 1910 and in 1911 at $217,299. The mica is a white muscovite, highly prized for its transparency, and used in the manufacture of gas-lamp chimneys and lamp shades, and in the stove trade. Other products of the State are barytes, gold, copper, iron ore, lime, millstones, abrasive garnet, precious stones, mineral waters, graphite, sand-lime brick, sand and gravel, silver, talc, and soapstone. A small quantity of tin ore has been mined in the State. Some of the talc produced in North Carolina is the highest grade found in the United States, and is used for complexion powder.

The following table shows the quantity and value of the mineral products of North Carolina in 1910 and 1911:

*Mineral production of North Carolina in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Barytes..short tons.. | (a) | (a) | | | (a) | (a) | | |
| Clay products..do.... | (a) (b) | (a) (b) | | $1,223,664 | 14,903 | b $130,610 | | $1,280,126 |
| Coal.....do.... | | | | | (a) | (a) | | |
| Copper.....pounds.. | | | 181,263 | 23,021 | | | 13,699 | 1,712 |
| Feldspar..short tons.. | | | | | (a) | (a) | | |
| Garnet, abrasive, short tons..... | (a) | (a) | | | (a) | (a) | | |
| Gems and precious stones..... | | | | 710 | | | | 10,735 |
| Gold, fine ounces (troy)..... | | | 3,120 | 64,500 | | | 3,478 | 71,900 |
| Graphite, amorphous, short tons..... | | | | | (a) | (a) | | |
| Iron ore...long tons.. | 65,278 | $114,237 | | | 84,782 | 148,369 | | |
| Lime.....short tons.. | | | 9,952 | 40,455 | | | 7,809 | 33,543 |
| Mica..... | | | | 230,460 | | | | 217,299 |
| Millstones..... | | | | (a) | | | | (a) |
| Mineral waters, gallons sold..... | 143,007 | 21,389 | | | 231,510 | 31,108 | | |
| Monazite and zircon, pounds..... | (a) | (a) | | | (a) | (a) | | |
| Sand and gravel, short tons..... | 62,935 | 13,406 | | | 251,977 | 93,336 | | |
| Sand-lime brick..... | | | | (a) | | | | |
| Silver, fine ounces (troy)..... | | | 8,300 | 4,500 | | | 1,000 | 500 |
| Stone..... | | (c) | | c 879,572 | | (c) | | c 826,928 |
| Talc and soapstone, short tons..... | (c) | (c) | (a) | (a) | (c) | (c) | (a) | (a) |
| Tin (concentrates), short tons..... | | | 1 | 700 | | | | |
| Miscellaneous..... | | 148,408 | | 84,836 | | 17,725 | | 63,874 |
| Total value, eliminating duplications. | $2,730,818 | | | | $2,797,155 | | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product includes raw product.

## NORTH DAKOTA.

The principal mineral product of North Dakota, which belongs to the Great Plains region, is lignite. It has been found to make an excellent fuel for burning brick, and the development of these two industries will probably coincide. The area underlain by lignite in North Dakota is larger than the coal area of any other State, with the exception of Montana. The lignite production of North Dakota in 1910 was 399,041 short tons, valued at $595,139, and in 1911 it was 502,628 tons, valued at $720,489. The brick made was valued at $227,455 in 1910 and at $210,616 in 1911. A small production of natural gas is made in the State. Some mineral waters are sold, and there is a small output of sand and gravel, and sand-lime brick.

The following table shows the quantity and value of the mineral products of North Dakota in 1910 and 1911:

*Mineral production of North Dakota in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products, short tons | (a) (b) | (a) (b) | | $227,455 | (a) (b) | (a) (b) | | $210,616 |
| Coal.....short tons | 399,041 | $595,139 | | | 502,628 | $720,489 | | |
| Mineral waters, gallons sold | (b) | (b) | | | (b) | (b) | | |
| Natural gas | | 7,010 | | | | 5,738 | | |
| Sand and gravel, short tons | 15,886 | 11,222 | | | 23,160 | 15,795 | | |
| Sand-lime brick | | | | (b) | | | | (b) |
| Miscellaneous | | (c) | | c 19,972 | | (c) | | c 5,607 |
| Total value, eliminating duplications | $860,233 | | | | $957,425 | | | |

a Value not included under total value.
b Value included under "Miscellaneous."
c Derived product includes raw product.

## OHIO.

Ohio is the premier State in the manufacture of clay products and in the manufacture of grindstones and pulpstones. It is second in the production of pig iron and lime; third in the value of its output of natural gas, salt, sand and gravel, gypsum, and oilstones; fourth in the production of coal and stone. Ohio is second among the States in the manufacture of pig iron, and although the total value of the pig-iron production approaches the combined value of all the other mineral products of the State, Ohio has no standing as a producer of iron ore. The ore used in the blast furnaces of Ohio is brought from Lake Superior. Exclusive of pig iron in 1910, the value of Ohio's mineral production was $100,004,982, and in 1911 $97,090,284. If pig iron were used as the basis of production Ohio would rank second, next to Pennsylvania, as a mineral-producing State. The production of pig iron eliminated, Ohio falls to fourth place, and West Virginia advances from fourth to third.

Of the products mined in Ohio, coal and clay are rivals for first place in the value of production. In 1909 the value of the clay production exceeded that of the coal; in 1910 coal held first place; and in 1911 the clay production again exceeded the value of coal. The production of coal in 1910 amounted to 34,209,668 short tons, valued at $35,932,288, decreasing to 30,759,986 short tons, valued at $31,810,123, in 1911. The value of the clay production on the other hand increased from $31,525,948 in 1910 to $32,663,895 in 1911. All of the coal production in Ohio is of bituminous variety, though some of it, like the block coal of Indiana, is usable raw in blast furnaces. When so used it is generally mixed with coke. The principal coal-producing counties are, in the order of their importance, Belmont, Athens, Jefferson, Guernsey, Perry, and Hocking, but

all of the counties on the east of Erie on the north and of Portsmouth on the south, with the exception of Ashtabula and Lake counties, are producers of coal. In 1882, at the beginning of this series of reports, Ohio's production of coal amounted to 9,450,000 tons. Its maximum of production was 34,209,668 short tons, which was reached in 1910.

Of the clay products, brick and tile represent about 60 per cent of the total value, and pottery about 40 per cent. In 1910, the brick and tile production of Ohio was valued at $17,231,236 and in 1911 at $17,888,630. The pottery products were worth $14,294,704 in 1910 and $14,775,265 in 1911. Sewer pipe represents the largest value in the products, with vitrified paving brick, second; common brick, third; tile (other than drain), fourth; drain tile, fifth; and fire brick, sixth. The principal producing counties are Muskingum, Summit, Stark, Jefferson, Cuyahoga, Tuscarawas, Perry, Scioto, Carroll and Athens. The pottery industry of Ohio is made up largely of the manufacture of high-grade pottery ware, most of the plants being along Ohio River, chiefly at Rookwood, near Cincinnati. Over 70 per cent of the total production of pottery in Ohio is white ware and other varieties of porcelain. Porcelain electrical supplies constitute important products.

The production of petroleum in Ohio in 1910 was 9,916,370 barrels, valued at $10,651,568; in 1911 it was 8,817,112 barrels, valued at $9,479,542. The production of natural gas was valued at $8,626,954 in 1910 and at $9,367,347 in 1911. The combined value of the fuels produced—that is, of coal, petroleum, and natural gas—was $55,210,810 in 1910 and $50,657,012 in 1911, which represents about 55 per cent of the production of the State, exclusive of pig iron. The principal petroleum-producing counties are Allen, Belmont, Carroll, Fairfield, Hancock, Harrison, Jefferson, Lucas, Monroe, Morgan, Noble, Perry, Sandusky, Seneca, Van Wert, Washington, and Wood; and the principal counties producing natural gas are Licking, Hocking, Knox, Ashland, and Fairfield.

The principal quarry production of Ohio is limestone, of which there is large quantity and great variety in this State. The use of this limestone is principally for road making, railroad ballast, and manufacture of concrete, and for iron flux. The principal producing counties are Allen, Erie, Franklin, Hamilton, Hardin, Lucas, Marion, Miami, Ottawa, Sandusky, Seneca, and Wood. The production of sandstone is equal to about one-third of that of the limestone. This is largely from the Berea sandstone which also produces the grindstones and pulpstones, in the production of which this State leads. The total value of stone produced in Ohio in 1910 was $5,759,563 and in 1911 it was $5,796,829. In the production of molding sand Ohio ranks first. This product constitutes about 25 per cent of the total sand and gravel production. All kinds of sands are produced in the State, the largest value being expressed by building sand. Gravel, used principally for railroad ballast, constitutes about 25 per cent of the sand and gravel used. The production of sand and gravel was valued in 1910 at $2,065,224 and in 1911 at $2,104,776. Other important mineral products of the State are lime, cement, salt, grindstones, pulpstones, coke (made from West Virginia coal), and gypsum. Less important products are bromine, calcium chloride, mineral waters, pyrite (as a by-product of coal mining), mineral paint, oilstones, and sand-lime brick.

The following table shows the quantity and value of the mineral products of Ohio in 1910 and 1911:

*Mineral production of Ohio in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Bromine..pounds.. | ..... | ..... | (a) | (a) | ..... | ..... | 116,872 | $17,737 |
| Calcium chloride, short tons..... | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Cement...barrels.. | ..... | ..... | 1,592,073 | $1,332,986 | ..... | ..... | 1,488,074 | 1,248,109 |
| Clay products, short tons..... | 325,308 | b $228,255 | ..... | 31,525,948 | 285,735 | b $206,668 | ..... | 32,663,895 |
| Coal....short tons.. | 34,209,668 | 35,932,288 | ..... | ..... | 30,759,986 | 31,810,123 | ..... | ..... |
| Coke.....do.... | ..... | ..... | 282,315 | b 911,987 | ..... | ..... | 311,382 | b 961,904 |
| Ferro-alloys, long tons..... | ..... | ..... | (a) (b) | (a) (b) | ..... | ..... | (a) (b) | (a) (b) |
| Grindstones and pulp stones..... | ..... | ..... | ..... | 699,033 | ..... | ..... | ..... | 742,107 |
| Gypsum, short tons | (a) | ..... | ..... | (a) | (a) | ..... | ..... | (a) |
| Iron ore..long tons.. | 22,320 | 35,866 | ..... | ..... | 16,697 | 30,549 | ..... | ..... |
| Iron, pig.....do.... | ..... | ..... | 5,584,279 | b 85,385,254 | ..... | ..... | 5,371,378 | b 73,484,592 |
| Lime...short tons.. | ..... | ..... | 415,285 | 1,647,335 | ..... | ..... | 405,562 | 1,607,524 |
| Mineral paints, natural pigments, short tons..... | ..... | ..... | (a) | (a) | ..... | ..... | ..... | ..... |
| Mineral waters, gallons sold..... | 2,226,188 | 95,989 | ..... | ..... | 1,958,547 | 86,478 | ..... | ..... |
| Natural gas..... | ..... | 8,626,954 | ..... | ..... | ..... | 9,367,347 | ..... | ..... |
| Oilstones and scythestones..... | ..... | ..... | ..... | (a) | ..... | ..... | ..... | (a) |
| Petroleum, barrels.. | 9,916,370 | 10,651,568 | ..... | ..... | 8,817,112 | 9,479,542 | ..... | ..... |
| Pyrite..long tons.. | 3,766 | 12,831 | ..... | ..... | 6,471 | 18,017 | ..... | ..... |
| Salt.....barrels.. | ..... | ..... | 3,673,850 | 951,963 | ..... | ..... | 4,302,507 | 1,100,453 |
| Sand and gravel, short tons..... | 5,106,514 | 2,065,224 | ..... | ..... | 5,281,637 | 2,104,776 | ..... | ..... |
| Sand-lime brick.... | ..... | ..... | ..... | (a) | ..... | ..... | ..... | (a) |
| Stone..... | ..... | 2,050,080 | ..... | 3,709,483 | ..... | (c) | ..... | c 5,796,829 |
| Sulphuric acid (60° Baumé),d short tons..... | ..... | ..... | ..... | (d) | ..... | ..... | (d) | (d) |
| Miscellaneous..... | ..... | ..... | ..... | 1,155,398 | ..... | ..... | ..... | 1,338,348 |
| Total value, eliminating duplications..... | $100,004,982 | | | | $97,090,284 | | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product includes stone sold rough.
d From zinc smelters. No report for 1910. Value included under "Miscellaneous."

## OKLAHOMA.

Since 1905 Oklahoma has increased rapidly in the production of petroleum and now ranks second among the States in that particular. Prior to 1904 the petroleum production of Oklahoma was insignificant. In that year considerable development work was done in the Osage Indian Reservation and in the vicinity of Bartlesville and Romona, in the Cherokee Nation of (then) Indian Territory. The production rose from less than 150,000 barrels in 1903 to nearly 1,400,000 barrels in 1904. By 1907 it had reached over 45,000,000 barrels, and at the present time, as the second oil producing State, Oklahoma is yielding oil at the rate of over 50,000,000 barrels annually. In 1910 the petroleum production of Oklahoma was 52,028,718 barrels, valued at $19,922,660; in 1911 it was 56,069,637 barrels, valued at $26,451,767. The value of the petroleum production is about 60 per cent of the total mineral output of the State.

The great increase in the production of petroleum, used largely for fuel, has naturally retarded the development of the coal resources of the State. According to the Tenth United States Census, 120,947 tons of coal were mined in Oklahoma (Indian Territory) in 1880, this being the first record of any coal produced in the then Territory. Coal production increased nearly every year until 1903, when it reached 3,517,388 tons. At this date the influence of petroleum, and of natural gas also, began to be felt, and coal mining has been practically at a standstill ever since. In only one year since has the production exceeded that of 1903, and this was in the boom period of 1907. The average yearly production from 1904 to 1911, inclusive, has been nearly half a million tons less than that of 1903. The production in 1911 was 3,074,242 short tons, valued at $6,291,494, against 2,646,226 tons, valued at $5,867,947, in 1910. The output in 1910 was cut down to an unusual extent by the strike of miners in all the Mississippi Valley States. Prior to the admission of Oklahoma as a State, the principal part of the production of coal was from the Choctaw Nation, with smaller quantities from the Cherokee and Creek Nations. Pittsburg County is now the leading producer, with Coal, Latimer, Okmulgee, and Haskell counties following in the order named. Four other counties also produce coal.

The following table shows the quantity and value of the mineral products of Oklahoma in 1910 and 1911:

*Mineral production of Oklahoma in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Asphalt..short tons.. | 11,959 | $65,244 | ..... | ..... | (a) | (a) | ..... | ..... |
| Cement.....barrels.. | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Clay products..... | ..... | ..... | ..... | $920,921 | ..... | ..... | ..... | $756,639 |
| Coal.....short tons.. | 2,646,226 | 5,867,947 | ..... | ..... | 3,074,242 | $6,291,494 | ..... | ..... |
| Coke.....do..... | ..... | ..... | (a) (b) | (a) (b) | ..... | ..... | ..... | ..... |
| Gypsum..short tons.. | 162,788 | ..... | ..... | 459,137 | 108,653 | ..... | ..... | 293,302 |
| Lead.....do..... | ..... | ..... | 1,805 | 158,840 | ..... | ..... | 1,925 | 173,250 |
| Lime.....do..... | ..... | ..... | 2,140 | 9,700 | ..... | ..... | 3,472 | 14,603 |
| Mineral waters, gallons sold..... | 115,000 | 4,950 | ..... | ..... | 497,074 | 14,290 | ..... | ..... |
| Natural gas..... | ..... | 3,490,704 | ..... | ..... | ..... | 6,731,770 | ..... | ..... |
| Petroleum...barrels.. | 52,028,718 | 19,922,660 | ..... | ..... | 56,069,637 | 26,451,767 | ..... | ..... |
| Pyrite....long tons.. | ..... | ..... | ..... | ..... | (a) | (a) | ..... | ..... |
| Salt.....barrels.. | ..... | ..... | 2,564 | 881 | ..... | ..... | 500 | 431 |
| Sand and gravel, short tons..... | 650,236 | 186,977 | ..... | ..... | 291,424 | 97,539 | ..... | ..... |
| Stone..... | ..... | 129,174 | ..... | 502,537 | ..... | (c) | ..... | c 795,879 |
| Zinc.....short tons.. | ..... | ..... | 2,297 | 248,076 | ..... | ..... | 2,247 | 256,158 |
| Miscellaneous..... | ..... | ..... | ..... | 1,032,417 | ..... | (c) | ..... | c 801,324 |
| Total value, eliminating duplications. | $32,988,865 | | | | $42,678,446 | | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product includes raw product.

Natural gas ranks second in value among the mineral products of Oklahoma, the output in 1910 being valued at $3,490,704, and in 1911 at $6,731,770. The three fuels considered by value make up 90 per cent of the total mineral production of the State.

The clay products are chiefly common and vitrified brick, the total value in 1910 being $920,921, and in 1911, $756,639. The principal counties in this regard are Muskogee, Rogers, and Tulsa.

The chief quarry product is limestone, about two-thirds of which is crushed for railroad ballast and concrete. The quarrying of granite, chiefly for building, is also of considerable importance in Greer, Johnston, Kiowa, and Sequoyah counties. The total stone production of the State was valued at $795,879 in 1911, against $631,711 in 1910.

Other mineral products to which Oklahoma contributes are asphalt, cement, gypsum, lead, lime, mineral waters, salt, sand, gravel, and zinc.

## OREGON.

Oregon has not risen to much prominence as a mining State, its production of only two substances attaining as much as $1,000,000 in value. Clay products, principally common and pressed brick, were valued at $1,081,025 in 1911, exclusive of a small output of pottery. The stone production was valued at $1,108,478 in 1910 but only $583,398 in 1911. In 1910 the clay products were valued at $876,632. The gold production of the State was $681,400 in 1910 and $634,200 in 1911. Sand (chiefly building) and gravel had a combined value of $625,405 in 1910 and of $659,417 in 1911. Some coal (lignite) has been produced in Coos County for a good many years, but the competition of fuel oil from California has taken away its chief market in San Francisco. Production has decreased from 87,276 tons in 1909 to 67,533 tons in 1910 and to 46,661 tons in 1911. Other products of the State are copper, lead, gypsum, lime, mineral waters, platinum, precious stones (irregularly), ocher, pottery, and silver.

The following table shows the quantity and value of the mineral products of Oregon in 1910 and 1911:

*Mineral production of Oregon in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products, short tons | [a] [c] | [a] [c] | | [b] $876,632 | 1,283 | [a] $7,053 | | [b] $1,081,025 |
| Coal, short tons | 67,533 | $235,229 | | | 46,661 | 108,033 | | |
| Copper, pounds | | | 22,022 | 2,797 | | | 125,943 | 15,743 |
| Gems and precious stones | | | | 100 | | | | 50 |
| Gold, fine ounces (troy) | | | 32,963 | 681,400 | | | 30,679 | 634,200 |
| Gypsum, short tons | 12,699 | | | 62,984 | | | | |
| Lead, do | | | | | | | 11 | 990 |
| Lime, do | | | 6,742 | 65,039 | | | 4,557 | 38,216 |
| Mineral paints, natural pigments, short tons | | | [c] | [c] | | | | |
| Mineral waters, gallons sold | 88,970 | 22,989 | | | 56,300 | 18,000 | | |
| Platinum, fine ounces (troy) | | | 53 | 1,121 | | | 117 | 3,265 |
| Sand and gravel, short tons | 1,432,495 | 625,405 | | | 1,438,504 | 659,417 | | |
| Silver, fine ounces (troy) | | | 43,800 | 23,600 | | | 44,800 | 24,200 |
| Stone | | [d] | | [d] 1,108,478 | | [d] | | [d] 583,398 |
| Miscellaneous | | | | 34,403 | | | | 32,259 |
| Total value, eliminating duplications | $3,739,927 | | | | $3,198,796 | | | |

[a] Value not included in total value.
[b] Exclusive of pottery, which is included under "Miscellaneous."
[c] Value included under "Miscellaneous."
[d] Derived product includes stone sold rough.

## PENNSYLVANIA.

Since the first records of mining statistics were written into the history of the United States, Pennsylvania has stood at the top of the list. Exclusive of the value of pig iron and of coke and of other derived or secondary products not included in the total made in the State, the value of Pennsylvania's mineral production is nearly one-fourth of that of the entire country, and exceeds by several million dollars the combined output of Illinois, Ohio, West Virginia, and California, the next four States in the value of their mineral production. The total value of the mineral production of Pennsylvania was $411,827,343 in 1910 and $414,112,373 in 1911. Pennsylvania holds the leadership primarily on account of the State's supremacy in the production of coal. In the combined value of the production of anthracite and bituminous coal Pennsylvania exceeds the aggregate value of all the mineral products of Illinois, West Virginia, and Ohio, the second, third, and fourth States, respectively, in rank. In addition to being the premier State in the production of coal, Pennsylvania leads also in the production of cement, lime, mineral paints, sand, slate, and stone, and in the manufacture of coke and pig iron. It is second in the value of clay products, of feldspar, graphite, and natural gas.

The production of coal in Pennsylvania in 1910 amounted to 235,006,762 short tons, valued at $313,304,812, of which 84,485,236 short tons, valued at $160,275,302, were anthracite and 150,521,526 short tons, valued at $153,029,510, were bituminous coal. In 1911 the production of bituminous coal decreased to 144,754,163 short tons, valued at $146,347,858, while that of anthracite increased to 90,464,067 short tons, valued at $175,189,392, so that whereas the total quantity increased only 211,468 tons to 235,218,230 tons, the value increased $8,232,438 to $321,537,250, owing to the higher value of anthracite, whose production increased approximately 6,000,000 tons while that of the lower priced bituminous coal decreased about the same quantity. As is well known, the entire production of anthracite is from a limited area, less than 500 square miles in extent, in the eastern part of the State. Ten counties contribute to the production, but 80 per cent or more of the total is mined in three counties: Luzerne, whose output exceeds 30,000,000 short tons a year, Lackawanna, which exceeds 20,000,000 tons, and Schuylkill, which produces from 16,000,000 to 18,000,000 tons. Northumberland County produces over 6,000,000 tons, Carbon over 3,000,000 tons, and about 3,000,000 tons is made up of the combined product of Columbia, Dauphin, Sullivan, Susquehanna, and Wayne counties. The bituminous coal fields extend over the greater part of the western half of the State and have a total area of more than 14,000 square miles. About 70 per cent of the production is from five counties: Fayette, whose maximum production in 1910 was over 31,000,000 tons, Westmoreland, whose production has reached (in 1907) nearly 29,000,000 tons, Allegheny, which approaches 19,000,000 tons, Washington and Cambria, each exceeding 16,000,000 tons. Three other counties, Clearfield, Indiana, and Somerset, have produced over 8,000,000 tons a year; one, Jefferson, exceeds 5,000,000 tons; one, Armstrong, has produced over 3,000,000 tons; and five others, Butler,

Center, Clarion, Elk, and Tioga, have mined over 1,000,000 tons. The first two counties, Fayette and Westmoreland, contain the famous Connellsville and Lower Connellsville coking coals, the fuel that makes that region the greatest coke-making district in the world.

Pennsylvania produces little iron ore, but the city of Pittsburgh and vicinity is the greatest iron-making district of the world. In 1910 Pennsylvania produced 739,799 long tons of iron ore, valued at $911,847, and in 1911, 514,929 tons, valued at $539,553. The production of pig iron (almost entirely from Lake Superior ores) was 11,014,652 long tons, valued at $174,486,833, in 1910, and 9,581,109 tons, valued at $136,328,507, in 1911.

The Lehigh cement district of eastern Pennsylvania (with a few plants in New Jersey) is the most important cement-making region in the world. The principal producing center is in the vicinity of Allentown. The Lehigh district as a whole makes about one-third the entire cement production of the United States, and it properly includes the counties of Northampton, Carbon, Lehigh, and Berks in Pennsylvania, and Hunter County in New Jersey. Other plants in Pennsylvania are located at York, Pittsburgh, Wampum, and Newcastle. The total production of cement in Pennsylvania in 1910 was 26,872,309 barrels, valued at $19,608,045, and 27,024,725 barrels, valued at $19,306,349, in 1911, of which nearly 90 per cent was from the Pennsylvania portion of the Lehigh district.

The clay products of Pennsylvania were valued at $22,094,285 in 1910 and at $20,270,033 in 1911. Pennsylvania ranks second among the States in the total value of its clay products, and first in the manufacture of the more ordinary types, such as brick of different kinds, terra cotta, tile, etc. In the output of pottery, New Jersey, Ohio, and West Virginia all exceed Pennsylvania. Expressed in value the output of fire brick is the most important of the clay products of Pennsylvania, the State's production of fire brick being more than one-third of the entire production of the United States, and about one-third of the value of all the brick and tile products in the State. The value of the fire brick produced in 1910 in Pennsylvania was $6,454,928, and in 1911 it was $5,555,529. Common brick is second in importance among the clay products, and the State's production was valued at $5,371,707 in 1910, and at $4,963,232 in 1911; front brick had a value of $2,001,967 in 1910 and of $2,111,492 in 1911; and vitrified brick in 1910 was valued at $1,204,724 and in 1911 at $1,511,061. All classes of brick, tile, and terra cotta are made in Pennsylvania, and the total value of this class of clay production in 1910 was $19,814,355 and in 1911 $18,113,216. The pottery products also include most of the varieties produced in the United States, valued at $2,279,930 in 1910 and at $2,156,817 in 1911. The principal clay-producing counties in the State are Philadelphia, Clearfield, Allegheny, Cambria, Beaver, Huntingdon, Armstrong, Elk, Clinton, and Lawrence.

Pennsylvania gave place in 1910 to West Virginia as first in rank in the value of the natural gas produced, but continues to rank first in consumption, both in quantity and value, of this fuel, making out the shortage in its own production by drawing from the West Virginia wells. West Virginia has exceeded Pennsylvania in the quantity of gas produced for several years. In 1910 the production of

natural gas in Pennsylvania fell off about 1,000,000,000 cubic feet, and that of West Virginia increased nearly 25,000,000,000 cubic feet, and the latter State exceeded Pennsylvania in the value of its natural gas production for the first time in its history. In 1911, West Virginia added over 16,000,000,000 cubic feet to its production while Pennsylvania fell off nearly 23,000,000,000 cubic feet, and in the value of its production West Virginia exceeded Pennsylvania over $10,000,000. West Virginia, however, consumes considerably less than one-half of the gas produced in the State, about three-fifths of its output being piped into Pennsylvania and Ohio for consumption.

Up to 1894 Pennsylvania was the leading State in the production of petroleum. In 1895 it was exceeded by Ohio, the production in Pennsylvania having begun to decline in 1891, while Ohio was approaching its maximum, which was attained in 1896. Both States have shown a declining tendency in the last 15 years. In more recent years West Virginia, Texas, California, Illinois, and Oklahoma have risen rapidly in the production of petroleum, and now Pennsylvania ranks eighth in the quantity of its oil production and fifth in the value.

The production of limestone is the principal factor in giving Pennsylvania first place as a producer of stone. Pennsylvania is also the first in the production of slate, of sand and gravel, and of lime. In 1910 the total value of the stone quarried in Pennsylvania was $8,571,518 and in 1911 it was $8,147,505; of this the production of limestone in 1910 was valued at $5,394,611 and in 1911 at $5,243,045.

The principal use of the limestone is for fluxing in the furnaces around Pittsburgh and Johnstown, and in the eastern and central parts of the State about 70 per cent of the total value of the limestone being used for this purpose. Next in importance to limestone is sandstone, which was valued at $1,595,070 in 1910 and at $1,333,309 in 1911. Trap rock, granite, and marble are also quarried. The principal leading counties in trap rock are Berks, Bucks, Delaware, and Montgomery; in granite, Berks, Bucks, Chester, Delaware, Lancaster, Lehigh, Montgomery, and Philadelphia; in marble, Chester, Luzerne, Montgomery, Northampton, and York. In the production of slate Pennsylvania is credited with about 60 per cent of the total output of the United States. In 1910 the State's production was valued at $3,740,806 out of a total for the United States of $6,236,759, and in 1911 at $3,431,351 out of a total of $5,728,019. The principal slate-producing region of the State is in Northampton and Lehigh counties. York is next in importance, producing the famous Peach Bottom slate. Smaller quantities are produced in Carbon and Lancaster counties.

Pennsylvania has more than one-half the total number of lime producers in the United States, but its production is about 25 per cent in quantity and 20 per cent in value of the total output. In 1910 the lime production in Pennsylvania was 877,714 short tons, valued at $2,440,350, and in 1911 it was 841,723 short tons, valued at $2,688,374. The burning of lime is an industry which is scattered pretty well all over the State. The combined production of sand and gravel in Pennsylvania in 1910 was 5,676,509 short tons, valued at $2,974,221, and in 1911 it was 5,689,059 tons, valued at $3,025,267.

In the manufacture of coke, as in the production of coal and in the manufacture of pig iron, Pennsylvania ranks preeminently above all the other States, with 60 per cent of the total production of coke. Owing to the slump in iron ore the manufacture of coke declined from 26,315,607 short tons, valued at $55,254,599, in 1910, to 21,923,935 short tons, valued at $43,053,367, in 1911. The principal counties, as is well known, that lead in the production of coke are Fayette and Westmoreland, and the districts of Connellsville and Lower Connellsville. Cambria, Clearfield, and Indiana are also important counties in the manufacture of coke.

The other mineral products of Pennsylvania are copper, feldspar, precious stones, gold, graphite, mineral paints, limestone, millstones, mineral waters, bromine, pyrite, quartz, salt, sand-lime brick, talc, and zinc oxide.

The following table gives the mineral production of Pennsylvania during 1910 and 1911:

*Mineral production of Pennsylvania in 1910 and 1911.*

| Product. | 1910 | | | |
|---|---|---|---|---|
| | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. |
| Abrasives, artificial.....pounds.. | | | (*a*) (*b*) | (*a*) (*b*) |
| Briquets, fuel.....short tons.. | | | (*c*) | (*c*) |
| Bromine.....pounds.. | | | (*b*) | (*b*) |
| Calcium chloride.....short tons.. | | | (*b*) | (*b*) |
| Cement.....barrels.. | | | *d* 26,872,309 | *d* $19,608,045 |
| Clay products.....short tons.. | 396,238 | *a* $636,613 | | 22,094,285 |
| Coal: | | | | |
| Anthracite.....do.... | 84,485,236 | 160,275,302 | | |
| Bituminous.....do.... | 150,521,526 | 153,029,510 | | |
| Coke.....do.... | | | 26,315,607 | *a* 55,254,599 |
| Copper.....pounds.. | | | 740,626 | 94,060 |
| Feldspar.....short tons.. | 15,091 | 104,751 | | |
| Ferro-alloys.....long tons.. | | | (*a*) (*b*) | (*a*) (*b*) |
| Gems and precious stones.. | | | | |
| Gold.....fine ounces (troy).. | | | (*b*) | (*b*) |
| Graphite, crystalline.....pounds.. | 1,392,767 | 82,194 | | |
| Iron ore.....long tons.. | 739,799 | 911,847 | | |
| Iron, pig.....do.... | | | 11,014,652 | *a* 174,486,833 |
| Lime.....short tons.. | | | 877,714 | 2,440,350 |
| Millstones.. | | | | (*b*) |
| Mineral paints, natural pigments...short tons.. | | | 28,091 | 265,559 |
| Zinc-lead pigments.....do.... | | | (*b*) | (*b*) |
| Mineral waters.....gallons sold.. | 2,536,337 | 221,685 | | |
| Natural gas.. | | 21,057,211 | | |
| Petroleum.....barrels.. | 8,794,662 | 11,908,914 | | |
| Pyrite.....long tons.. | | | | |
| Quartz.....short tons.. | (*b*) | (*b*) | | |
| Sand and gravel.....do.... | 5,676,509 | 2,974,221 | | |
| Sand-lime brick.. | | | | 72,827 |
| Salt.....barrels.. | | | (*b*) | (*b*) |
| Silver.....fine ounces (troy).. | | | (*b*) | (*b*) |
| Slate.. | | | | 3,740,806 |
| Stone.. | | (*c*) | | *e* 8,571,518 |
| Sulphuric acid (60° Baumé)*f*.....short tons.. | | | | (*c*) |
| Talc.....do.... | (*c*) | (*c*) | (*b*) | (*b*) |
| Miscellaneous.. | | (*c*) | | *e* 9,229,525 |
| Total value, eliminating duplications..... | | | $411,827,343 | |

*a* Value not included in total value.
*b* Value included under "Miscellaneous."
*c* No report for 1910.
*d* Exclusive of puzzolan cement, which is included under "Miscellaneous."
*e* Derived product includes raw product.
*f* From zinc smelters. Value included under "Miscellaneous."

*Mineral production of Pennsylvania in 1910 and 1911*—Continued.

| Product. | 1911 | | | |
|---|---|---|---|---|
| | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. |
| Abrasives, artificial.....pounds.. | ..... | ..... | (*a*) (*b*) | (*a*) (*b*) |
| Briquets, fuel.....short tons.. | ..... | ..... | 94,426 | *a* $223,613 |
| Bromine.....pounds.. | ..... | ..... | (*b*) | (*b*) |
| Calcium chloride.....short tons.. | ..... | ..... | (*b*) | (*a*) |
| Cement.....barrels.. | ..... | ..... | 27,024,725 | 19,306,349 |
| Clay products.....short tons.. | 329,197 | *a* $567,622 | ..... | 20,270,033 |
| Coal: | | | | |
| Anthracite.....do.... | 90,464,067 | 175,189,392 | ..... | ..... |
| Bituminous.....do.... | 144,754,163 | 146,347,858 | ..... | ..... |
| Coke.....do.... | ..... | ..... | 21,923,935 | *a* 43,053,367 |
| Copper.....pounds.. | ..... | ..... | 661,621 | 82,703 |
| Feldspar.....short tons.. | 13,284 | 101,090 | ..... | ..... |
| Ferro-alloys.....long tons.. | ..... | ..... | (*a*) (*b*) | (*a*) (*b*) |
| Gems and precious stones..... | ..... | ..... | ..... | 300 |
| Gold.....fine ounces (troy).. | ..... | ..... | (*b*) | (*b*) |
| Graphite, crystalline.....pounds.. | (*b*) | (*b*) | ..... | ..... |
| Iron ore.....long tons.. | 514,929 | 539,553 | ..... | ..... |
| Iron, pig.....do.... | ..... | ..... | 9,581,109 | *a* 136,328,507 |
| Lime.....short tons.. | ..... | ..... | 841,723 | 2,688,374 |
| Millstones..... | ..... | ..... | ..... | (*b*) |
| Mineral paints, natural pigments...short tons.. | ..... | ..... | 26,749 | 262,520 |
| Zinc-lead pigments.....do.... | ..... | ..... | (*b*) | (*b*) |
| Mineral waters.....gallons sold.. | 2,327,732 | 216,819 | ..... | ..... |
| Natural gas..... | ..... | 18,010,796 | ..... | ..... |
| Petroleum.....barrels.. | 8,248,158 | 10,894,074 | ..... | ..... |
| Pyrite.....long tons.. | (*b*) | (*b*) | ..... | ..... |
| Quartz.....short tons.. | (*b*) | (*b*) | ..... | ..... |
| Sand and gravel.....do.... | 5,689,059 | 3,025,267 | ..... | ..... |
| Sand-lime brick..... | ..... | ..... | ..... | (*b*) |
| Salt.....barrels.. | ..... | ..... | (*b*) | (*b*) |
| Silver.....fine ounces (troy).. | ..... | ..... | (*b*) | (*b*) |
| Slate..... | ..... | ..... | ..... | 3,431,351 |
| Stone..... | ..... | (*c*) | ..... | *c* 8,147,505 |
| Sulphuric acid (60° Baumé)*d*.....short tons.. | ..... | ..... | (*d*) | (*d*) |
| Talc.....do.... | (*c*) | (*c*) | (*b*) | (*b*) |
| Miscellaneous..... | ..... | 99,147 | ..... | 11,101,415 |
| Total value, eliminating duplications..... | $414,112,373 | | | |

*a* Value not included in total value.
*b* Value included under "Miscellaneous."
*c* Derived product includes raw product.
*d* From zinc smelters. Value included under "Miscellaneous."

## RHODE ISLAND.

The only products which Rhode Island has contributed during the last few years are stone, mineral waters, lime, talc, soapstone, and manufactures of clay.

The coal deposits of Rhode Island, which furnished fuel some years ago, have not recently been operated. This coal is of a highly refractory character and is more of a graphitic nature than anthracite, but it is generally designated "Rhode Island anthracite." During 1911 steps were taken to reopen one of these old mines at Portsmouth, but up to the close of the year no commercial production was reported. Some of this graphitic coal has been mined for use as furnace linings. On account of the fact that there are less than three operators in each of the other few industries in the State, mineral waters and stone are the only products that can be mentioned separately. The sales of mineral water in 1910 amounted to 528,725 gallons, valued at $34,703, and in 1911 to 503,360 gallons, valued at $27,036. The stone production was valued at $521,889 in

1910 and at $958,753 in 1911. The combined value of the other mineral products was $243,911 in 1910 and $158,686 in 1911.

The following table gives the quantity and value of the mineral production of Rhode Island for 1910 and 1911:

*Mineral production of Rhode Island in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Briquets, fuel, short tons | ..... | ..... | (a) | (a) | ..... | ..... | (b) (c) | (b) (c) |
| Clay products | ..... | ..... | ..... | (c) | ..... | ..... | ..... | (c) |
| Lime.....short tons | ..... | ..... | (c) | (c) | ..... | ..... | (c) | (c) |
| Mineral waters, gallons sold | 528,725 | $34,703 | ..... | ..... | 503,360 | $27,036 | ..... | ..... |
| Stone | ..... | (d) | ..... | d$521,889 | ..... | (d) | ..... | d$958,753 |
| Talc.....short tons | ..... | ..... | (c) | (c) | (d) | (d) | (c) | (c) |
| Miscellaneous | ..... | ..... | ..... | 243,911 | ..... | ..... | ..... | 158,686 |
| Total value, eliminating duplications | $800,503 | | | | $1,088,475 | | | |

a No report for 1910.
b Value not included in total value.
c Value included under "Miscellaneous."
d Derived product includes raw product.

## SOUTH CAROLINA.

The most important mineral industry in South Carolina is the mining of phosphate rock. This does not have the same actual or relative importance at the present time that it did in the latter years of the last century. Until the discovery of the phosphate beds in Florida in 1888 South Carolina enjoyed practically a monopoly in the production of phosphate rock. With the development of the more extensive beds in Florida, South Carolina soon lost its supremacy in the production of this substance. In 1894 the production of rock in Florida exceeded that of South Carolina, and the former State has continued to hold first place since that time. Two varieties of phosphate rock were produced in South Carolina, known as land rock and river rock, the names indicating the sources from which the rock was obtained. The river-bed deposits have practically been worked out and the land deposits are approaching exhaustion. In 1893 the production of phosphate rock in South Carolina reached its maximum, when the production was 502,564 long tons. In 1910 there were 179,659 long tons, valued at $733,057, and in 1911 169,156 long tons, valued at $673,156. South Carolina now ranks third as the producer of phosphate rock, being exceeded not only by Florida but by Tennessee. The discovery of the phosphatic character of the Tennessee deposits was not made until in 1894, and the production of South Carolina fell behind Tennessee in 1898.

The only other industry of considerable importance in South Carolina is clay working, of which the brickyards furnish by far the greater part of the output. In 1910 the value of all the clay products of South Carolina was $704,590, of which $657,801 was the value of common brick. In 1911 the total value of the clay products was $669,794, of which common brick represented $624,103. South Caro-

lina is one of three States to produce a peculiar quality of clay used in the paper trade and known as "paper clay." None of this production, however, is used within the State, but is shipped to paper manufacturers in the North. The production of "paper clay" in South Carolina in 1910 was 29,051 short tons, valued at $118,926, out of a total production of raw clay amounting to 29,920 short tons, valued at $122,567. In 1911 the quantity of raw clay mined and sold as such was 31,585 short tons, valued at $124,063, of which 30,640 short tons, valued at $120,012, was used as paper clay. The entire output of paper clay reported was from Aiken County alone.

South Carolina is one of two States in which monazite has been produced in commercial quantities, the other and more important producer being North Carolina. The production in the two States has exceeded 1,500,000 pounds and the value has exceeded $160,000, but during the last two years on account of heavy imports from Brazil the production in both States has practically ceased. In 1909 the total production of monazite in North Carolina and South Carolina was 541,931 pounds, valued at $65,032; in 1910 it was 15,847 pounds, valued at $1,902; and in 1911 no commercial production was reported, though a few thousand pounds of crude sand were mined and stocked.

The production of gold in South Carolina in 1910 was 1,829 fine ounces, valued at $37,800, and in 1911 it was 972 fine ounces, valued at $20,100. The Haile gold mine, in Lancaster County, has been the chief source of South Carolina's gold production. Other mineral products of the State are mica, mineral waters, lime, stone, sand, and gravel. The stone production, which is almost entirely granite, was valued at $369,448 in 1910, and at $194,598 in 1911.

The following table gives the quantity and value of mineral production of South Carolina in 1910 and 1911:

*Mineral production of South Carolina in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Barytes..short tons.. | ..... | ..... | ..... | ..... | (a) | (a) | ..... | ..... |
| Clay products, short tons..... | 29,920 | b$122,567 | ..... | $704,590 | 31,585 | b$124,063 | ..... | $669,794 |
| Fuller's earth, short tons..... | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Gold, fine ounces (troy)..... | ..... | ..... | 1,829 | 37,800 | ..... | ..... | 972 | 20,100 |
| Lime.....short tons.. | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Mica..... | ..... | ..... | ..... | (a) | ..... | ..... | ..... | ..... |
| Mineral waters, gallons sold..... | 410,691 | 78,465 | ..... | ..... | 285,389 | 42,099 | ..... | ..... |
| Monazite....pounds.. | (a) | (a) | ..... | ..... | ..... | ..... | ..... | ..... |
| Phosphate rock, long tons..... | 179,659 | 733,057 | ..... | ..... | 169,156 | 673,156 | ..... | ..... |
| Sand and gravel, short tons... ..... | 504,282 | 52,918 | ..... | ..... | 227,612 | 30,303 | ..... | ..... |
| Stone..... | ..... | (c) | ..... | c369,855 | ..... | (c) | ..... | c336,467 |
| Miscellaneous..... | ..... | 3,902 | ..... | 40,784 | ..... | (c) | ..... | c32,196 |
| Total value, eliminating duplications.. | $2,021,371 | | | | $1,804,115 | | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product includes raw product.

## SOUTH DAKOTA.

The chief mining district of South Dakota is in the Black Hills region in Lawrence County, and the mainstay of the State, from a mining standpoint, is the production of gold, in which South Dakota ranks fifth among the States. In 1910 the production of gold in South Dakota, most of which was from the Homestake mine of the Black Hills region, was 260,267 fine ounces, valued at $5,380,200. In 1911 it was 359,402 fine ounces, valued at $7,429,500. The value of the gold represents 90 per cent of the total mineral output of South Dakota. Other branches of the mining industry fall into insignificance.

In one respect, however, South Dakota practically stands alone, and that is that in both 1909 and 1910 there was some production of tin, but none in 1911. A small quantity is also reported to have been mined in North Carolina, and prospects of tin production are held out in the Territory of Alaska.

Second in importance among the mineral products of the State is that of quartzite, a hard variety of sandstone used largely for building and paving. In 1910 the stone production was valued at $173,726, decreasing to $148,190 in 1911. The production of silver was 120,600 fine ounces, valued at $65,100, in 1910, and 200,300 fine ounces, valued at $108,200, in 1911.

The following table gives the quantity and value of the mineral production of South Dakota in 1910 and 1911:

*Mineral production of South Dakota in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Clay products | | | | $71,200 | | | | $61,365 |
| Copper.....pounds.. | | | 43 | 5 | | | 1,607 | 201 |
| Gems and precious stones | | | | 2,537 | | | | 1,644 |
| Gold, fine ounces (troy) | | | 260,267 | 5,380,200 | | | 359,402 | 7,429,500 |
| Gypsum .short tons.. | (a) | | | (a) | (a) | | | (a) |
| Lead.....do.... | | | 7 | 616 | | | 33 | 2,970 |
| Lime.....do.... | | | 4,151 | 25,399 | | | 5,293 | 37,573 |
| Lithium.....do.... | (a) | (a) | | | (a) | (a) | | |
| Mica | | | | (a) | | | | (a) |
| Mineral waters, gallons sold | (a) | (a) | | | 13,400 | $2,410 | | |
| Natural gas | | $31,999 | | | | 16,984 | | |
| Sand and gravel, short tons | 849,800 | 157,738 | | | 92,757 | 41,286 | | |
| Sand-lime brick | | | | (a) | | | | 31,535 |
| Silver, fine ounces (troy) | | | 120,600 | 65,100 | | | 200,300 | 108,200 |
| Stone | | 43,058 | | 130,668 | | (b) | | b 148,190 |
| Tin.....short tons.. | | | 18 | 12,600 | | | | |
| Tungsten ore (60 per cent concentrates, short tons | | | 300 | 64 | | | | |
| Miscellaneous | | 4,091 | | 170,539 | | (b) | | b 155,514 |
| Total value, eliminating duplications.. | $6,095,814 | | | | $8,037,372 | | | |

a Value included under "Miscellaneous." b Derived product includes raw product.

The clay products consist principally of common brick, with smaller portions of front brick, drain tile, and fire brick, which amounted to $71,200 in 1910 and to $61,365 in 1911. Other less important products are cement, copper, gypsum, lead, lime, mica, mineral waters, natural gas, sand-lime brick, sand and gravel, and tungsten ore.

## TENNESSEE.

The most important mineral resource of Tennessee is coal, the value of the output of which is equal to 40 per cent of the State's total mineral production. Exclusive of the value of pig iron made in the State, but including the value of the iron ore mined, the total value of the mineral products of Tennessee in 1910 was $17,150,742, and in 1911 it was $17,902,451. Of these totals the coal produced in 1910 contributed $7,925,350 (7,121,380 short tons), and in 1911, $7,209,734 (6,433,156 short tons). All of the coal-producing counties are in the eastern part of the State, which is crossed in a northeast-southwest direction by the coal areas of the Appalachian system. The three principal producing counties, Campbell, Claiborne, and Anderson, are at the northern end of the Tennessee coal field. This section produces the celebrated Jellico coal, highly prized as a steam and domestic fuel. Other important coal-producing counties are Marion, Morgan, Scott, White, Grundy, and Hamilton. All of the coal produced in the State is bituminous in character, some of it possessing excellent coking quality. Coke is made in six counties and is consumed in the iron furnaces at Rockwood, at Dayton, and in the vicinity of Chattanooga.

Tennessee's production of pig iron amounted to 400,269 long tons, valued at $5,199,099, in 1910 and to 297,594 long tons, valued at $3,439,644, in 1911, mostly from ore mined within the State. In 1910 the iron ore produced in Tennessee amounted to 732,247 long tons, valued at $1,048,323, and in 1911 it was 469,728 tons, valued at $632,339. The iron ore occurs in close proximity to the coking coals and is mined chiefly in Roane, Lawrence, Hickman, and Wayne counties.

In the production of copper Tennessee is the only one of importance among the Eastern States, and ranks seventh in this respect among all the States, though when compared with the great copper production of Michigan, Montana, and Arizona, the output of Tennessee appears unimportant. The entire production of the State is from pyritic ores mined in Polk County and smelted at Ducktown. The production in 1911 was 18,965,143 pounds, valued at $2,370,643, against 16,691,777 pounds, valued at $2,119,856, in 1910. The agitation in the last few years against the emission of sulphur-laden fumes from the smelter stacks and the efforts of the operators to control them have resulted in the construction of a plant for the recovery in the form of acid of the sulphur contained in the ore. Work on this plant was begun in 1906, but was not in full operation until in 1908; it was enlarged in 1910, and now has a capacity of from 180,000 to 200,000 tons of 60° Baumé acid annually. The operations of this plant are described in considerable detail in the report on sulphur, pyrite, and sulphuric acid in Part II of the present report.

The discovery in 1894 of extensive beds of phosphate rock in Tennessee has developed into an industry now fourth in importance among

the mining and related enterprises of the State, and Tennessee now ranks second among the States in the production of this mineral substance, with an output exceeding $1,500,000 in value. The deposits occur in the central part of the State in Hickman, Maury, Williamson, Perry, and Lewis counties, and are of three types, brown, blue, and white rock, the first being by far the most important commercially. The production of phosphate rock in Tennessee was 398,188 long tons, valued at $1,503,350, in 1910 (including a small quantity from Arkansas) and 431,566 tons, valued at $1,688,267, in 1911.

The following table gives the quantity and value of the mineral products of Tennessee during 1910 and 1911:

*Mineral production of Tennessee in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Barytes...short tons.. | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Bauxite...long tons.. | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Cement.....barrels.. | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Clay products, short tons..... | 61,407 | b $120,753 | ..... | $1,414,288 | 49,653 | b $104,277 | ..... | $1,385,100 |
| Coal.....short tons.. | 7,121,380 | 7,925,350 | ..... | ..... | 6,433,156 | 7,209,734 | ..... | ..... |
| Coke.....do.... | ..... | ..... | 322,756 | b 959,104 | ..... | ..... | 330,418 | b 797,758 |
| Copper.....pounds.. | ..... | ..... | 16,691,777 | 2,119,856 | ..... | ..... | 18,965,143 | 2,370,643 |
| Ferro-alloys, long tons..... | ..... | ..... | (a) (b) | (a) (b) | ..... | ..... | (a) (b) | (a) (b) |
| Gold, fine ounces (troy)..... | ..... | ..... | 135 | 2,800 | ..... | ..... | 576 | 11,900 |
| Iron ore...long tons.. | 732,247 | 1,048,323 | ..... | ..... | 469,728 | 632,339 | ..... | ..... |
| Iron, pig.....do.... | ..... | ..... | 400,269 | b 5,199,099 | ..... | ..... | 297,594 | b 3,439,644 |
| Lime....short tons.. | ..... | ..... | 88,679 | 275,701 | ..... | ..... | 91,099 | 282,763 |
| Mineral paints, natural pigments, short tons.. | ..... | ..... | 4,584 | 38,194 | ..... | ..... | (a) | (a) |
| Mineral waters, gallons sold..... | 950,511 | 71,129 | ..... | ..... | 1,073,115 | 72,475 | ..... | ..... |
| Natural gas..... | ..... | 300 | ..... | ..... | ..... | 300 | ..... | ..... |
| Phosphate rock, long tons..... | (a) | (a) | ..... | ..... | 431,566 | 1,688,267 | ..... | ..... |
| Quartz...short tons.. | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Sand and gravel, short tons..... | 795,412 | 417,901 | ..... | ..... | 1,117,309 | 518,542 | ..... | ..... |
| Silver, fine ounces (troy)..... | ..... | ..... | 69,800 | 37,700 | ..... | ..... | 107,000 | 57,800 |
| Slate..... | ..... | ..... | ..... | (a) | ..... | ..... | ..... | ..... |
| Stone..... | ..... | (c) | ..... | c 1,455,482 | ..... | (c) | ..... | c 1,498,798 |
| Sulphuric acid (60° Baumé), d short tons..... | ..... | ..... | ..... | (d) | ..... | ..... | (d) | (d) |
| Zinc.....do.... | ..... | ..... | 925 | 99,900 | ..... | ..... | 1,000 | 114,000 |
| Miscellaneous..... | ..... | 1,542,645 | ..... | 855,633 | ..... | 49,403 | ..... | 2,303,647 |
| Total value, eliminating duplications.. | | $17,150,742 | | | | $17,902,451 | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product includes stone sold rough.
d From copper smelters. No report for 1910. Value included under "Miscellaneous."

Fifth in importance in Tennessee's mineral production is the output of the quarries, nearly equally divided in value between marble and limestone. Tennessee marbles have a high reputation for interior decoration and approximately 75 per cent of the entire output is sold for that purpose. The limestone is used chiefly for roadmaking, railroad ballast, concrete, and furnace flux. The principal marble-

producing counties are Blount, Hawkins, Knox, Loudoun, and Union, and those producing the larger part of the limestone are Bradley, Campbell, Carter, Cheatham, Coffee, Cumberland, Davidson, Dickson, Franklin, Giles, Hamilton, Hickman, Jefferson, Knox, Marion, Maury, Rhea, Roane, Robertson, Sullivan, Trousdale, and Wilson. The total value of the stone production of Tennessee was $1,455,482 in 1910 and $1,498,798 in 1911.

The chief clay products of Tennessee are common and front brick and pottery. The value of the clay products in 1911 was $1,385,100 against $1,414,288 in 1910. The pottery products had a value of $209,180 in 1910 and of $197,139 in 1911. In addition to these, 61,407 short tons of raw clay, valued at $120,753, in 1910, and 49,653 short tons, valued at $104,277, in 1911 were mined and sold. The leading raw clay product is ball clay, in the production of which Tennessee holds second place. The counties leading in the output of clay products are Hamilton, Davidson, Shelby, and Knox.

Other products are barytes, bauxite, Portland cement, gold, lime, manganese ore, mineral paints, mineral waters, natural gas, silver, zinc, sand, and gravel.

## TEXAS.

Texas, the largest State in area, and the fifth in the number of inhabitants, is twenty-third in the value of its mineral production. It does not hold first place as a producer of any mineral or mineral substance, but ranks second in the production of two—asphalt and quicksilver. Its principal mineral product is petroleum, in which it ranks sixth among the States in quantity of output and seventh in value. The value of the petroleum product represents something more than one-third of the total for the State. In 1910 the production of petroleum was 8,899,266 barrels, valued at $6,605,755, and the total value of all mineral products was $18,404,254. In 1911 the production of petroleum amounted to 9,526,474 barrels, valued at $6,554,552 and the total value of all products was $18,817,304.

Among the older Texas oil fields there was in 1911 an interesting increase at Markham. The other oil fields show the usual slight decline. The feature of the greatest interest in petroleum in Texas was the discovery and development of the Electra pool in Wichita County, on the northern edge of the State. The oil in this field proves to be of an exceptionally fine quality, being almost identical with Pennsylvania oil. There is considerable prospect of extending this pool to the southeast and the southwest, and good indications of oil are found as far east as half way to the next producing region, in Clay County. The latter district has not been as profitable as the new Electra field, but has yielded sufficient gas to supply Wichita Falls, Dallas, and Fort Worth. Much prospecting is going on in the western half of Texas in many different localities, where seepages and other indications show the probability of fine oil supplies.

Second in importance, reckoned by value of the output, is coal, including lignite, the combined production of which was 1,892,176 short tons, valued at $3,160,965, in 1910 and 1,974,593 tons, valued at $3,273,288, in 1911. Texas is the only State in the Union that produces considerable quantities of both true bituminous coal and lignite or brown coal. The areas of true coal are much less in extent than those of the lignites but contribute something over half of the output

and about 80 per cent of the total value. In 1910 the production of bituminous coal was 1,010,944 short tons, valued at $2,397,858, and that of lignite was 881,232 tons, valued at $763,107. In 1911 the production of bituminous coal amounted to 1,083,952 tons, valued at $2,491,361, and that of lignite was 890,641 tons, valued at $781,927. Bituminous coal is produced in six counties—Erath, Palo Pinto, Wise, and Young, in the north central part of the State, and Maverick and Webb on the Mexican border. The lignite areas extend in a broad belt from the Sabine to the Rio Grande, but production is limited at present to 11 counties, of which the principal ones are Milam and Wood.

The following table gives the quantity and value of the mineral products of Texas in 1910 and 1911:

*Mineral production of Texas in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Asphalt...short tons | | | 57,713 | $1,040,825 | | | 55,826 | $786,785 |
| Cement.....barrels | | | (a) | (a) | | | (a) | (a) |
| Clay products, short tons | 1,114 | [b] $5,786 | | 2,863,930 | 2,070 | [b] $9,480 | | 2,659,919 |
| Coal.....short tons | 1,892,176 | 3,160,965 | | | 1,974,593 | 3,273,288 | | |
| Copper.....pounds | | | 2,961 | 376 | | | 105 | 13 |
| Fuller's earth, short tons | (a) | (a) | | | (a) | (a) | | |
| Gems and precious stones | | | | 834 | | | | 2,600 |
| Gold, fine ounces (troy) | | | 19 | 400 | | | 189 | 3,900 |
| Gypsum..short tons | 188,559 | | | 488,646 | 179,625 | | | 491,685 |
| Iron ore...long tons | 29,535 | 34,003 | | | | | | |
| Lead.....short tons | | | 33 | 2,904 | | | 57 | 5,130 |
| Lime.....do | | | 48,200 | 226,952 | | | 43,064 | 218,007 |
| Mineral waters, gallons sold | 1,241,248 | 128,549 | | | 1,637,932 | 158,367 | | |
| Natural gas | | (a) | | | | 1,014,945 | | |
| Petroleum...barrels | 8,899,266 | 6,605,755 | | | 9,526,474 | 6,554,552 | | |
| Quicksilver...flasks | | | 3,320 | 154,413 | | | (a) | (a) |
| Salt.....barrels | | | 382,164 | 272,568 | | | 385,200 | 299,537 |
| Sand and gravel, short tons | 1,006,584 | 517,225 | | | 1,048,352 | 543,866 | | |
| Sand-lime brick | | | | (a) | | | | (a) |
| Silver, fine ounces (troy) | | | 364,400 | 196,800 | | | 444,200 | 239,900 |
| Stone | | 241,152 | | 313,467 | | (c) | | [c] 588,777 |
| Tin.....short tons | | | 3 | 2,587 | | | 5 | 4,226 |
| Miscellaneous | | 455,857 | | 1,696,046 | | (c) | | [c] 1,971,807 |
| Total value, eliminating duplications | $18,404,254 | | | | $18,817,304 | | | |

[a] Value included under "Miscellaneous."
[b] Value not included in total value.
[c] Derived product includes raw product.

The clay products of Texas were valued at $2,659,919 in 1911 against $2,863,930 in 1910. The principal products are common brick, vitrified brick, and front brick, the first constituting about 60 per cent of the total. Pottery products included in these totals were valued at $119,085 in 1910 and at $132,417 in 1911. The principal clay-working counties are Ellis, Bowie, Wilson, Bastrop, and Harris.

The manufacture of Portland cement is of comparatively recent development in Texas, but the production has increased rapidly from

less than 500,000 barrels in 1908 to over 650,000 barrels in 1909, to nearly 1,300,000 barrels in 1910, and to 1,504,511 barrels in 1911. Cement materials are abundantly distributed but present operations are confined to 4 plants, 2 near Dallas, 1 at San Antonio, and 1 at El Paso.

The asphalt production of Texas, which is principally residue from heavy asphaltic oils, amounted to 57,713 short tons, valued at $1,040,825, in 1910, and 55,826 tons, valued at $786,785, in 1911.

The production of quicksilver, in which Texas ranks second among the States, is from Brewster County, in the western part of the State.

The principal quarry product is limestone, produced in Bell, Bexar, Brown, Comal, Coryell, Dallas, El Paso, Grayson, Guadalupe, Jack, Jones, Lampasas, Nolan, Palo Pinto, Polk, Runnels, Travis, and Williamson counties, and is used for building, for foundations, for road making, for concrete, and for flux. Granite is produced in Burnet, El Paso, and Llano counties. The red granite of Burnet County has few equals in attractiveness in this country.

Other mineral products of Texas are fuller's earth, copper, precious stones, gold, lead, lime, mineral waters, natural gas, gypsum, iron ore, pig iron, salt, sand-lime brick, silver, sand and gravel.

## UTAH.

Utah is unique among the States in the diversity of its production of precious and semiprecious metals. It does not rank first in the production of any of these metals, but it stands well among the leaders in the production of gold, silver, copper, lead, zinc, and vanadium minerals. In the production of lead and silver it ranks third; it ranks fourth in the production of copper, sixth in the production of gold, and seventh in the production of zinc. Forty per cent of the total production of the State is from the copper mines, of which the most important producing district is the Bingham, in Salt Lake County. The Tintic district, in Juab County, and the San Francisco district, in Beaver County, are less important copper producers. The quantity of copper produced in 1910 was 125,185,455 pounds, valued at $15,898,553, and in 1911 it was 142,340,215 pounds, valued at $17,792,527. The silver mines are in Juab, Summit, Wasatch, and Utah counties, with smaller quantities from Salt Lake, Beaver, and Tooele counties, and the production was valued at $5,640,800 in 1910 and at $6,280,500 in 1911.

The principal silver-producing counties are also the chief producers of lead, the output of which was 57,081 short tons, valued at $5,023,128, in 1910, and 55,198 short tons, valued at $4,967,820, in 1911. Gold is the fourth in importance among the metal products of the State, and it amounted in 1910 to 208,627 fine ounces, valued at $4,312,700; in 1911 the gold production was 217,020 fine ounces, valued at $4,486,200. The principal producing counties are Juab, Salt Lake, and Tooele; small amounts come from Utah, Summit, Wasatch, Beaver, Boxelder, Morgan, Iron, and Piute, and a small placer production from other counties. About 25 per cent of the gold is obtained from dry or siliceous ores, but most of the output is obtained in the refining of copper. Some of the lead and zinc ores also produce gold.

The zinc production, which is chiefly from middlings and concentrates from the Park City district, amounted in 1910 to 7,221 short

tons, valued at $779,868, and in 1911 to 7,004 short tons, valued at $798,456. The value of the metal production of Utah in 1910 was $31,655,049 out of a total value of all mineral production of $39,233,716; in 1911 the metal production was valued at $34,325,503 out of a total value of $41,139,075. More than one-half of the remainder is obtained from coal mines, which in 1910 produced 2,517,809 short tons, valued at $4,224,556, and in 1911, 2,513,175 short tons, valued at $4,248,666. The principal coal-producing county is Carbon, which contains part of the Uinta coal basin, extending from central Utah nearly through the central part of Colorado. The developments are principally along the line of the Denver & Rio Grande Railroad. Some of the Carbon County coal possesses coking qualities. From 250,000 to 350,000 tons are made into coke annually, chiefly from the slack produced in the coal-mining operations.

The following table gives the quantity and value of the mineral production of Utah during 1910 and 1911:

*Mineral production of Utah in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Asphalt..short tons.. | 34,942 | $526,298 | 755 | $43,035 | 30,846 | $516,614 | ..... | ..... |
| Cement.....barrels.. | ..... | ..... | 811,800 | 1,005,960 | ..... | ..... | 662,849 | $827,523 |
| Clay products, short tons..... | 6,209 | [a] 8,903 | ..... | [b] 864,258 | 3,776 | [a] 9,241 | ..... | [b] 548,955 |
| Coal .....short tons.. | 2,517,809 | 4,224,556 | ..... | ..... | 2,513,175 | 4,248,666 | ..... | ..... |
| Coke.....do.... | ..... | ..... | [a] [c] | [a] [c] | ..... | ..... | [a] [c] | [a] [c] |
| Copper.....pounds.. | ..... | ..... | 125,185,455 | 15,898,553 | ..... | ..... | 142,340,215 | 17,792,527 |
| Gems and precious stones..... | ..... | ..... | ..... | 13,200 | ..... | ..... | ..... | 4,625 |
| Gold, fine ounces (troy)..... | ..... | ..... | 208,627 | 4,312,700 | ..... | ..... | 217,020 | 4,486,200 |
| Gypsum .short tons.. | [c] | ..... | ..... | [c] | [c] | ..... | ..... | [c] |
| Lead.....do.... | ..... | ..... | 57,081 | 5,023,128 | ..... | ..... | 55,198 | 4,967,820 |
| Lime.....do.... | ..... | ..... | 15,625 | 88,030 | ..... | ..... | 11,681 | 74,770 |
| Mineral waters, gallons sold..... | [c] | [c] | ..... | ..... | [c] | [c] | ..... | ..... |
| Petroleum...barrels.. | [c] | [c] | ..... | ..... | [c] | [c] | ..... | ..... |
| Phosphate rock, long tons..... | [c] | [c] | ..... | ..... | [c] | [c] | ..... | ..... |
| Salt.....barrels.. | 44,771 | 13,804 | 205,079 | 172,065 | 36,242 | 14,244 | 236,178 | 157,024 |
| Sand and gravel, short tons..... | 183,494 | 21,354 | ..... | ..... | 144,857 | 25,889 | ..... | ..... |
| Scythestones..... | ..... | ..... | ..... | [c] | ..... | ..... | ..... | ..... |
| Silver, fine ounces (troy)..... | ..... | ..... | 10,445,900 | 5,640,800 | ..... | ..... | 11,630,600 | 6,280,500 |
| Stone..... | ..... | [d] | ..... | [d] 440,775 | ..... | [d] | ..... | [d] 215,657 |
| Sulphur...long tons.. | [c] | [c] | ..... | ..... | [c] | [c] | ..... | ..... |
| Uranium and vanadium ores, short tons..... | ..... | ..... | ..... | ..... | ..... | ..... | [c] | [c] |
| Zinc.....short tons.. | ..... | ..... | 7,221 | 779,868 | ..... | ..... | 7,004 | 798,456 |
| Miscellaneous..... | ..... | 22,542 | ..... | 732,842 | ..... | 43,311 | ..... | 1,113,193 |
| Total value, eliminating duplications..... | $39,233,716 | | | | $41,139,075 | | | |

[a] Value not included in total value.
[b] Exclusive of pottery, which is included under "Miscellaneous."
[c] Value included under "Miscellaneous."
[d] Derived product includes stone sold rough.

The manufacture of Portland cement began in Utah in 1910, with an output of 811,800 barrels, valued at $1,005,960. The industry

appears to have been overdone in the first year, for the production dropped in 1911 to 662,849 barrels, valued at $827,523.

Clay products of the State consist chiefly of common brick and front brick, with smaller amounts of vitrified brick, drain and other tile, and a small output of pottery. The value of the clay products decreased, exclusive of pottery, from $864,258 in 1910 to $548,955 in 1911. The principal stone quarried in Utah is limestone, the larger part of which is used for flux in the smelters, although some is used for foundation work and also for building purposes. The limestone quarries are located principally in Cache, Morgan, Salt Lake, San Juan, San Pete, Tooele, and Utah counties. Utah produces also sandstone and granite. Other mineral products are asphalt, precious stones, lime, salt (gathered on the shores of the Great Salt Lake), arsenic, bismuth, graphite, gypsum, mineral waters, petroleum, phosphate rock, pottery, sulphur, vanadium minerals, sand, and gravel.

## VERMONT.

Vermont's principal claim to distinction as a mining State is in the output of its marble, granite, and slate quarries. Vermont is the leading State in the production of both marble and granite, and second in the production of slate. The marble quarries are chiefly in Rutland County in the west-central part of the State and in the immediate vicinity of Rutland and Proctor, with smaller quantities in Franklin County in the northwestern part and Bennington County in the southwestern part of the State. The granite quarries are along the eastern borders, the principal producing counties being Washington and Orange, lying almost due northeast from the marble-producing region. The slate production is almost exclusively from Rutland County. The total production of stone in Vermont in 1910 was valued at $6,282,574, of which $3,562,850 was marble and $2,694,474 was granite. Limestone to the value of $25,250 was produced. The slate production was valued at $1,894,659—a total value for all quarry products of $8,177,233. In 1911 the marble production was valued at $3,394,930, the granite at $2,730,719, the limestone at $19,702, and the slate at $1,624,941—the total value for all quarry products being $7,770,292. The total value of all mineral products of Vermont was $8,720,409 in 1910, and $8,434,516 in 1911, so that the quarries are responsible for over 90 per cent of the State's total production. If to these the value of the scythestones and soapstone be added the quarry products represent 97 per cent of the total value of the State's mineral output. The lime production in 1910 was 38,667 short tons, valued at $203,606, and in 1911 it was 37,333 tons, valued at $191,035. The production of soapstone, including talc, was 25,975 short tons in 1910, valued at $136,674; and 29,488 short tons, valued at $200,015 for 1911. Considerable development of asbestos properties has been in progress in Vermont in the last few years, and this promises to be an important industry in the State. The other less important productions are copper, mineral paints, clay products, mineral waters, sand, and gravel.

The following table gives the quantity and value of the mineral production of Vermont during 1910 and 1911:

*Mineral production of Vermont in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Asbestos .short tons.. | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Clay products.do.... | 6,060 | b $34,038 | ..... | $89,253 | (a) (b) | (a) (b) | ..... | $86,466 |
| Copper.....pounds.. | ..... | ..... | 1,935 | 246 | ..... | ..... | ..... | ..... |
| Lime.....short tons.. | ..... | ..... | 38,667 | 203,606 | ..... | ..... | 37,333 | 191,035 |
| Mineral paints, natural pigments, short tons..... | ..... | ..... | 609 | 5,935 | ..... | ..... | 504 | 5,047 |
| Mineral waters, gallons sold..... | 137,875 | 16,660 | ..... | ..... | 25,200 | $9,346 | ..... | ..... |
| Scythestones..... | ..... | ..... | ..... | (a) | ..... | ..... | ..... | (a) |
| Sand and gravel, short tons..... | 66,418 | 19,047 | ..... | ..... | 104,852 | 52,540 | ..... | ..... |
| Slate..... | ..... | ..... | ..... | 1,894,659 | ..... | ..... | ..... | 1,624,941 |
| Stone..... | ..... | 2,036,369 | ..... | 4,246,205 | ..... | (c) | ..... | c6,145,351 |
| Talc and soapstone, short tons..... | (c) | (c) | c 25,975 | c 136,674 | (c) | (c) | c 29,488 | c 200,015 |
| Miscellaneous..... | ..... | (c) | ..... | c 71,755 | ..... | (c) | ..... | c 164,672 |
| Total value, eliminating duplications ... | $8,720,409 | | | | $8,434,516 | | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product includes raw product.

## VIRGINIA.

Exclusive of the production of pig iron and inclusive of the value of iron ore produced, the total value of the mineral production of Virginia in 1910 was $13,898,516 and in 1911 it was $13,609,364. The principal production included in this total was coal, the output of which in 1910 was 6,507,997 short tons, valued at $5,877,486, and in 1911 was 6,864,667 short tons, valued at $6,254,804. Virginia is credited with having produced the first coal mined in the United States from a small basin contained in Henrico and Chesterfield counties in the eastern part of the State, near Richmond. Coal was known to exist in this locality as early as 1710, and before the close of the century shipments were made from this region to some of the Northern States. With the development of the more abundant and higher grade of coals of the Appalachian region, the industry in the eastern part of the State lagged and for a number of years the mines were not in operation. They were reopened in 1910 and in 1911 were again at a producing stage. The chief production of coal, however, is in Wise, Tazewell, Lee, and Russell counties in the southwestern portion of the State, the area of which belongs to the Appalachian system. The mining of coal in southwestern Virginia was coincident with the first Survey report on the mineral resources of the United States. The first shipment from the Pocahontas district in Tazewell County was made to Norfolk in 1883. In 1888 the production of this region had exceeded 1,000,000 tons. In 1892 the Wise County fields were opened, and in 1897 the production from this new

district exceeded that of Tazewell County. The mines in Lee County were opened in 1905, and development of properties in Russell County have been active during the last two or three years. The output of 1911 was the largest ever obtained.

The production of pig iron in Virginia, the value of which is not included in the total, amounted in 1910 to 402,625 long tons, valued at $5,576,599, decreasing in 1911 to 308,789 long tons, valued at $3,898,285. Most of the blast furnaces are located in the southwestern part of the State, convenient to the iron ores and fuels. The iron-ore production of Virginia, most of which is brown ore, amounted to 903,377 long tons, valued at $1,845,144, in 1910, and to 610,871 long tons, valued at $1,146,188, in 1911. It is produced principally in Botetourt, Allegheny, Pulaski, and Wythe counties, and the larger part is used in the furnaces of the companies operating the mines.

Most of the coals mined in the southwestern part of Virginia possess coking qualities, although 2 banks of ovens, 1 at Low Moor and 1 at Covington, are supplied with coal from the New River district in West Virginia. The total production of coke in Virginia in 1910 was 1,493,655 short tons, valued at $2,731,348, and in 1911, in sympathy with the decrease in the production of iron ore and the manufacture of pig iron, it was 910,411 short tons, valued at $1,615,609.

The value of the clay products of Virginia in 1911 were valued at $1,739,900 against $1,839,687 in 1910. Common brick represents 80 per cent of the total value, and about 18 per cent is represented by the value of front brick. A smaller quantity of ornamental and fire brick and tile is also produced. The value of the output of the stone quarries was $1,000,089 in 1910 and $821,798 in 1911, the principal stones produced being granite and limestones. The principal granite operations are in the vicinity of Richmond in Henrico County. The granite of this area has a high reputation as a building stone. A large portion of the production is crushed for use in roadmaking, railroad ballast, and concrete. Considerable quantities of limestone are also used for these purposes, but the larger portion of the output is consumed as flux in the iron furnaces. Virginia is the leading State in the production of manganese ore and of pyrite and is the only producer of rutile. Virginia stands first in the production of soapstone, most of which is manufactured into various heat-resisting articles, such as hearthstones, mantels, griddles, sinks, etc., before being marketed. The quarries are located in the soapstone belt, which has its greatest development in Albemarle and Nelson counties. The production in 1910 amounted to 25,908 short tons, valued in the condition in which first sold at $510,781, and in 1911 the production was 26,759 short tons, valued at $660,926. The production of lime, which might also be included in the output of the stone quarries, was 141,257 short tons, valued at $563,567, in 1910 and 132,133 short tons, valued at $483,016, in 1911.

Other products of less importance are barytes, copper, cement, feldspar, precious stones (occasionally), gypsum, lead, mica, millstones (in which Virginia ranks second), mineral paints, mineral waters, salt, sand-lime brick, gold, silver, slate, zinc, sand, and gravel.

The following table gives the mineral production of Virginia during 1910 and 1911:

*Mineral production of Virginia in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Asbestos..short tons | ..... | ..... | ..... | ..... | (a) | (a) | ..... | ..... |
| Barytes.....do | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Cement.....barrels | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Clay products, short tons | 530 | b $1,486 | ..... | $1,839,687 | 10,666 | b $3,087 | ..... | $1,739,900 |
| Coal.....short tons | 6,507,997 | 5,877,486 | ..... | ..... | 6,864,667 | 6,254,804 | ..... | ..... |
| Coke.....do | ..... | ..... | 1,493,655 | b2,731,348 | ..... | ..... | 910,411 | b1,615,609 |
| Copper.....pounds | ..... | ..... | 105,313 | 13,375 | ..... | ..... | ..... | ..... |
| Feldspar..short tons | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Ferro-alloys, long tons | ..... | ..... | (a) (b) | (a) (b) | ..... | ..... | (a) (b) | (a) (b) |
| Gold, fine ounces (troy) | ..... | ..... | 44 | 900 | ..... | ..... | 150 | 3,100 |
| Gypsum..short tons | (a) | ..... | ..... | (a) | (a) | ..... | ..... | (a) |
| Infusorial earth | ..... | ..... | ..... | (a) | ..... | ..... | ..... | (a) |
| Iron ore...long tons | 903,377 | 1,845,144 | ..... | ..... | 610,871 | 1,146,188 | ..... | ..... |
| Iron, pig.....do | ..... | ..... | 402,625 | b5,576,599 | ..... | ..... | 308,789 | b3,898,285 |
| Lead.....short tons | ..... | ..... | 87 | 7,656 | ..... | ..... | 400 | 36,000 |
| Lime.....do | ..... | ..... | 141,257 | 563,567 | ..... | ..... | 132,133 | 483,016 |
| Manganese ore and manganiferous ore, long tons | 2,059 | 18,509 | ..... | ..... | 2,962 | 25,770 | ..... | ..... |
| Mica | ..... | ..... | ..... | ..... | ..... | ..... | ..... | (a) |
| Millstones | ..... | ..... | ..... | 5,273 | ..... | ..... | ..... | 17,635 |
| Mineral paints, natural pigments, short tons | ..... | ..... | ..... | ..... | ..... | ..... | (a) | (a) |
| Mineral waters, gallons sold | 2,441,923 | 301,523 | ..... | ..... | 2,474,918 | 298,701 | ..... | ..... |
| Pyrite....long tons | (a) | (a) | ..... | ..... | 150,800 | 558,494 | ..... | ..... |
| Rutile...short tons | ..... | ..... | 566 | 44,480 | ..... | ..... | ..... | ..... |
| Salt.....barrels | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Sand and gravel, short tons | 764,321 | 215,416 | ..... | ..... | 553,996 | 204,170 | ..... | ..... |
| Sand-lime brick | ..... | ..... | ..... | (a) | ..... | ..... | ..... | ..... |
| Silver, fine ounces (troy) | ..... | ..... | 200 | 100 | ..... | ..... | 200 | 100 |
| Slate | ..... | ..... | ..... | 148,721 | ..... | ..... | ..... | 188,808 |
| Stone | ..... | 386,354 | ..... | 613,735 | ..... | (c) | ..... | c821,798 |
| Talc and soapstone, short tons | (c) | (c) | c25,908 | c510,781 | (c) | (c) | c26,759 | c660,926 |
| Zinc.....short tons | ..... | ..... | 1,168 | 126,144 | ..... | ..... | 228 | 25,992 |
| Miscellaneous | ..... | 536,677 | ..... | 891,988 | ..... | 14,688 | ..... | 1,171,274 |
| Total value, eliminating duplications | | $13,898,516 | | | | $13,609,364 | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product includes raw product.

## WASHINGTON.

Washington is the only State on the Pacific coasts in which coal is the chief product, and it is also the only one of the three Pacific coast States in which coal mining is an industry of any importance. In 1910 out of the total production, valued at $16,693,030, that of the coal output represented $9,764,465, or approximately 60 per cent. In 1911, out of a total value for the State of $15,853,556, the coal output was valued at $8,174,170, or 51.6 per cent. The smaller production of coal in 1911, it having decreased from 3,911,899 short tons in 1910, to 3,572,815 short tons, was due to the competition of

fuel oil from California. The advantages of fuel oil are so marked, particularly as a sparkless fuel in the heavily forested State of Washington, that transportation companies having their own coal mines are using oil in their locomotives from Portland and Puget Sound through and beyond the forested areas. The maximum of production of coal in Washington was that attained in 1910. Coal mining began in Washington as early as in 1860, when the United States Census reported an output of 5,374 short tons. In 1882, the first of the thirty years of which Mineral Resources has kept record, the production had increased to 177,340 tons. Before the end of that decade, however, in 1888, active exploitation of the coal areas of Washington began, and the output had exceeded 1,200,000 tons. It passed the 2,000,000-ton mark in 1899, and four years later exceeded 3,000,000 tons. It would probably have passed the 4,000,000-ton mark in 1911 except for the competition of fuel oil. With the exception of a small area, known as the Roslyn field on the eastern edge of the Cascade Mountains in Kittitas County, the principal coal fields of Washington are in close proximity to Puget Sound, Seattle and Tacoma obtaining their fuel supply from mines less than 50 miles distant. The principal producing counties are King, Kittitas, and Pierce. Some of the Pierce County coal makes a fair grade of coke, and ovens located at Fairfax and Wilkeson make coke from the slack coal produced in the mining operations. All the coal is washed before coking, and most of the coke is sold to the smelter at Tacoma; smaller quantities going to Portland and Seattle for foundry use.

Next to coal the chief mining industry in Washington is clay working, of which the principal products are sewer pipe, common brick, asbestos, terra cotta, fireproofing, in the order named. Washington is one of only two States in which the manufacture of sewer pipe constitutes the most important of the clay products. The clay-working industries in 1910 produced wares to the value of $3,023,854 and in 1911, $2,840,372. The principal producing counties are King, Spokane, and Stevens.

The principal stone products of Washington are granite and sandstone, with smaller amounts of marble and limestone. Unlike coal mining and clay working the quarry industry in Washington showed an increase in 1911 over 1910. The total value of the stone production increased from $1,118,059 in 1910 to $1,679,872 in 1911. The granite, most of which is produced in Clarke, Cowlitz, King, Lewis, Pierce, Snohomish, Spokane, and Yakima counties, increased from $642,992 in 1910 to $1,345,551 in 1911. The limestone, produced chiefly in San Juan and Snohomish counties, decreased from $438,538 in 1910 to $32,478 in 1911. Washington produces small quantities of gold and silver. In 1910 the gold production amounted to 38,990 fine ounces, valued at $806,000, and the silver to 204,900 fine ounces, valued at $110,600. In 1911 the production of gold was 40,635 fine ounces, valued at $840,000 and that of silver was 230,300 ounces, valued at $124,400. The digging of gravel for concrete and railroad ballast is an industry of some importance. The principal production of sand is for building. The total production of sand and gravel amounted to 1,575,289 short tons, valued at $481,569, in 1910, and to 1,145,369 short tons, valued at $338,400, in 1911. Tungsten

ore to the value of $51,768 was produced in 1910. Other substances produced are arsenic, cement, copper, mineral paints, precious stones (occasionally), lead, lime, sand-lime brick, mineral waters, pig iron, zinc-lead, and zinc pigment.

The following table gives the quantity and value of the mineral production of Washington in 1910 and 1911:

*Mineral production of Washington in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Briquets, fuel, short tons | | | [a] | [a] | | | [b] [c] | [b] [c] |
| Cement.....barrels | | | [c] | [c] | | | 960,573 | $1,496,807 |
| Clay products, short tons | 3,851 | [b] $7,132 | | [d]$3,023,854 | 1,187 | [b]$2,753 | | [d]2,840,372 |
| Coal.....short tons | 3,911,899 | 9,764,465 | | | 3,572,815 | 8,174,170 | | |
| Coke.....do | | | 59,337 | [b] 347,540 | | | 40,180 | [b] 216,262 |
| Copper.....pounds | | | 65,021 | 8,258 | | | 195,503 | 24,438 |
| Gold, fine ounces, (troy) | | | 38,990 | 806,000 | | | 40,635 | 840,000 |
| Gypsum,[e] short tons | | | | | | | | |
| Iron ore...long tons | [c] | [c] | | | | | | |
| Iron, pig.....do | | | [b] [c] | [b] [c] | | | | |
| Lead.....short tons | | | 311 | 27,368 | | | 601 | 54,090 |
| Lime.....do | | | 35,540 | 267,735 | | | 35,094 | 228,933 |
| Mineral paints, natural pigments, short tons | | | [c] | [c] | | | [c] | [c] |
| Zinc-lead pigments, short tons | | | [c] | [c] | | | | |
| Mineral waters, gallons sold | 31,200 | 12,571 | | | 148,800 | 14,654 | | |
| Sand and gravel, short tons | 1,575,289 | 481,569 | | | 1,145,369 | 338,400 | | |
| Sand-lime brick | | | | [c] | | | | [c] |
| Silver, fine ounces, (troy) | | | 204,900 | 110,600 | | | 230,300 | 124,400 |
| Stone | | [f] | | [f] 1,118,059 | | [f] | | [f] 1,679,872 |
| Tungsten ore (60 per cent concentrates) short tons | | | 103 | 51,768 | | | [c] | [c] |
| Zinc.....short tons | | | | | | | 12 | 1,368 |
| Miscellaneous | | [f] | | [f] 1,148,561 | | | | 75,052 |
| Total value eliminating duplications | $16,693,030 | | | | $15,853,556 | | | |

[a] No report for 1910.
[b] Value not included in total value.
[c] Value included under "Miscellaneous."
[d] Exclusion of pottery, which is included under "Miscellaneous."
[e] No gypsum mined. Alaskan gypsum calcined in Washington.
[f] Derived product includes raw product.

## WEST VIRGINIA.

West Virginia bases its claim to distinction in the mining industry as a producer of solid, liquid, and gaseous fuels. In the production of coal West Virginia ranks second in quantity and third in value of its output; in the production of petroleum it ranks fourth; and in the production of natural gas it stands at the head of all the States. These three fuels represent 90 per cent of the total mineral production as expressed in values. Coal alone constitutes over 50 per cent, natural gas over 20 per cent, and petroleum over 15 per cent. In

the total value of its mineral production West Virginia ranked second in 1910, with $102,477,594, and third, with $101,948,248, in 1911, and though more than 90 per cent of its total mineral production is represented by its fuels, it ranks thirty-fourth in the value of its manufactures. Not more than 20 per cent of the coal, petroleum, and natural gas produced in West Virginia is consumed for useful purposes within the State. The principal consumption of coal in West Virginia is by the locomotives hauling the trains, carrying the coal and the coke outside of the State's borders. With the largest supply of coking coal in the United States and ranking second in the quantity of coke produced, West Virginia manufactured only 222,135 long tons of pig iron in 1910 and 287,472 tons in 1911. The production of coke in West Virginia was 3,803,850 short tons, valued at $7,354,059, in 1910, and 2,291,049 short tons, valued at $4,236,845, in 1911. This does not, however, represent by any means the total quantity of coke made from West Virginia coal, as ovens at Low Moor and Covington in Virginia, at Indianapolis and Gary in Indiana, at Chicago and Joliet in Illinois, and at Hamilton and Cleveland in Ohio, draw their supplies of coal from the West Virginia mines. In the 30 years during which the volumes of Mineral Resources have been published, the coal production of West Virginia has increased nearly thirtyfold. In 1882 the production of the State was estimated at 2,240,000 short tons, which was probably slightly in excess of the actual production, as in 1881 it had amounted to 1,680,000 short tons. In 1910, the year of the maximum output, the production amounted to 61,671,019 short tons, valued at $56,665,061. In 1911 the production of coal amounted to 59,831,580 short tons, valued at $53,670,515. The principal producing counties are Fayette, Kanawha, Logan, McDowell, Mercer, Putnam, and Mingo, in the southern part of the State, and Barbour, Harrison, Marion, Mineral, Preston, Taylor, and Tucker, in the northern part of the State. Coal is produced in 35 out of 55 counties in the State.

The petroleum production, which amounted to 11,753,071 barrels valued at $15,723,544 in 1910 and to 9,795,464 barrels valued at $12,767,293 in 1911, is principally from Ritchie, Pleasants, Tyler, Wetzel, and Harrison counties. It is impossible to make a county distribution of the production of natural gas.

Next to fuels, the clay products are the most important, and of these the value of the pottery represents two-thirds of the total. West Virginia is third among the States in the value of pottery products, being exceeded only by Ohio and New Jersey. Of the other clay products, vitrified brick is the most important, followed by common brick, tile, and fire brick. The first trial in the United States of vitrified brick as a paving material was made in Charleston, W. Va. The total value of the clay products was $3,998,045 in 1910, of which $2,675,588 was the value of the pottery. In 1911 the total value of the clay products was $4,333,420, of which the pottery products constituted $2,880,202. The principal quarry products are limestone and sandstone, the latter predominating in proportion of about four to one. The northern part of the Shenandoah Valley is particularly rich in limestone suitable for iron-furnace flux, and approximately 70 per cent of the limestone produced in the State is for this purpose. The remainder is chiefly crushed stone used for railroad ballast, roadmaking, and concrete; a little is also used for

building. The value of the quarry products was $1,106,012 in 1911, against $1,054,192 in 1910. The sand and gravel production of West Virginia amounted to 745,241 short tons, valued at $474,461, in 1910, and to 749,391 short tons, valued at $532,388, in 1911, about 60 per cent of the value being in the output of glass sand, in which West Virginia ranks next to Pennsylvania.

Other less important products of the State are bromine, calcium chloride, cement, grindstones, iron ore, lime, mineral waters, and salt.

The following table gives the quantity and value of the mineral production of West Virginia during 1910 and 1911:

*Mineral production of West Virginia in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Bromine....pounds.. | ..... | ..... | (a) | (a) | ..... | ..... | 77,908 | $12,322 |
| Calcium chloride, short tons..... | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Cement.....barrels.. | ..... | ..... | (a) | (a) | ..... | ..... | (a) | (a) |
| Clay products, short tons..... | 69,630 | b $51,543 | ..... | $3,998,045 | 73,304 | b $48,576 | ..... | 4,333,420 |
| Coal.....short tons.. | 61,671,019 | 56,665,061 | ..... | ..... | 59,831,580 | 53,670,515 | ..... | ..... |
| Coke.....do.... | ..... | ..... | 3,803,850 | b7,354,039 | ..... | ..... | 2,291,049 | b4,236,845 |
| Grindstones..... | ..... | ..... | ..... | (a) | ..... | ..... | ..... | (a) |
| Iron ore...long tons.. | (a) | (a) | ..... | ..... | (a) | (a) | ..... | ..... |
| Iron, pig.....do.... | ..... | ..... | (a) (b) | (a) (b) | ..... | ..... | (a) (b) | (a) (b) |
| Lime.....short tons.. | ..... | ..... | 90,419 | 274,205 | ..... | ..... | 179,966 | 536,660 |
| Mineral waters, gallons sold..... | 336,444 | 81,742 | ..... | ..... | 259,686 | 67,687 | ..... | ..... |
| Natural gas..... | ..... | 23,816,553 | ..... | ..... | ..... | 28,451,907 | ..... | ..... |
| Petroleum...barrels.. | 11,753,071 | 15,723,544 | ..... | ..... | 9,795,464 | 12,767,293 | ..... | ..... |
| Salt.....do.... | ..... | ..... | 155,625 | 62,955 | ..... | ..... | 183,379 | 78,805 |
| Sand and gravel .....short tons.. | 745,241 | 474,461 | ..... | ..... | 749,391 | 532,388 | ..... | ..... |
| Stone..... | ..... | (c) | ..... | c1,054,192 | ..... | (c) | ..... | c1,106,012 |
| Miscellaneous..... | ..... | (c) | ..... | c3,658,961 | ..... | (c) | ..... | c4,415,847 |
| Total value, eliminating duplications.. | $102,477,594 | | | | $101,948,248 | | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product includes raw product.

## WISCONSIN.

The product in which Wisconsin leads all other States is mineral waters. The output of mineral waters in Wisconsin is chiefly from the Waukesha Springs in Waukesha County, the value of which exceeds that of the output from the Saratoga Springs in New York. The value of the mineral waters produced in Wisconsin in 1910 was $974,366, decreasing to $955,988 in 1911, whereas the value of the waters sold in New York was $858,635 in 1910 and $939,003 in 1911. Although Wisconsin leads in the value of mineral waters, the most important mineral product of the State is iron ore. Wisconsin is included in the Lake Superior iron-ore district, portions of the Menominee and Gogebic ranges extending from Michigan into Wisconsin. Wisconsin is, however, much behind Minnesota and Michigan in the quantity of iron ore produced, only about 2 per cent of the total production of the Lake Superior region being credited to Wisconsin. The production in Wisconsin in 1911 was a little less than one-half what it was in 1910, the figures being 1,149,551 long tons, valued at

$3,610,349, in 1910, and 559,763 long tons, valued at $1,386,616, in 1911.

Wisconsin is the third State in the Union in the production of lime and fourth in the production of zinc and pyrite. The zinc production of Wisconsin in 1910 was 19,752 short tons, valued at $2,133,216, and in 1911 it was 31,809 short tons, valued at $3,626,226. The lime production was 248,238 short tons, valued at $959,405, in 1910, and 250,638 short tons, valued at $961,558, in 1911. The principal quarry products are granite and limestone. The former, quarried chiefly in Douglas, Green Lake, Marathon, Marquette, Marinette, Waupaca, and Waushara counties, was valued at $475,342 in 1910 and at $1,382,309 in 1911. Limestone, valued at $979,522 in 1910 and at $848,363 in 1911, is quarried in Brown, Buffalo, Dane, Dodge, Door, Fond du Lac, Grant, Green Lake, Iowa, Kewaunee, La Crosse, Marathon, Milwaukee, Outagamie, Ozaukee, Racine, Sheboygan, Vernon, Walworth, Waukesha, and Winnebago counties. The other products are clay, graphite, gypsum, lead, mineral paints, pig iron, quartz, sand-lime brick, sand and gravel, and zinc oxide. The total value of the mineral production of Wisconsin was $12,451,436 in 1911, against $13,084,021 in 1910.

The following table gives the quantity and value of the mineral production of Wisconsin by substances during 1910 and 1911:

*Mineral production of Wisconsin in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Briquets, fuel, short tons | ..... | ..... | (a) | (a) | ..... | ..... | (b) (c) | (b) (c) |
| Clay products, short tons | 359 | b $518 | ..... | $1,176,883 | 586 | b $1,222 | ..... | $1,158,139 |
| Coke.....short tons | ..... | ..... | (b) (c) | (b) (c) | ..... | ..... | (b) (c) | (b) (c) |
| Graphite, amorphous, short tons | (c) | (c) | ..... | ..... | (c) | (c) | ..... | ..... |
| Gypsum.short tons | ..... | ..... | ..... | ..... | ..... | ..... | ..... | (d) |
| Iron ore...long tons | 1,149,551 | 3,610,349 | ..... | ..... | 559,763 | 1,386,616 | ..... | ..... |
| Iron, pig.....do | ..... | ..... | 278,232 | b4,386,859 | ..... | ..... | 245,152 | b3,803,049 |
| Lead.....short tons | ..... | ..... | 3,884 | 341,792 | ..... | ..... | 3,967 | 357,030 |
| Lime.....do | ..... | ..... | 248,238 | 959,405 | ..... | ..... | 250,638 | 961,558 |
| Manganiferous ore, long tons | (e) | (e) | ..... | ..... | (e) | (e) | ..... | ..... |
| Mineral paints, natural pigments, short tons | ..... | ..... | 2,057 | 14,916 | ..... | ..... | 2,048 | 11,258 |
| Zinc-lead pigments, short tons | ..... | ..... | (c) | (c) | ..... | ..... | (c) | (c) |
| Mineral waters, gallons sold | 6,400,812 | 974,366 | ..... | ..... | 5,716,162 | 955,988 | ..... | ..... |
| Pyrite....long tons | 12,555 | 49,467 | ..... | ..... | 12,893 | 50,025 | ..... | ..... |
| Quartz...short tons | (c) | (c) | ..... | ..... | (c) | (c) | ..... | ..... |
| Sand and gravel, short tons | 1,451,758 | 425,563 | ..... | ..... | 3,676,855 | 731,692 | ..... | ..... |
| Sand-lime brick | ..... | ..... | ..... | 29,399 | ..... | ..... | ..... | 68,312 |
| Stone | ..... | 375,486 | ..... | 2,269,032 | ..... | (f) | ..... | f2,375,102 |
| Zinc.....short tons | ..... | ..... | 19,752 | 2,133,216 | ..... | ..... | 31,809 | 3,626,226 |
| Miscellaneous | ..... | (f) | ..... | f3,121,629 | ..... | 30,418 | ..... | 3,118,746 |
| Total value, eliminating duplications | $13,084,021 | | | | $12,451,436 | | | |

a No report for 1910.
b Value not included in total value.
c Value included under "Miscellaneous."
d Not mined, but calcined in Wisconsin. Value included under "Miscellaneous."
e Tonnage and value included in iron ore.
f Derived product includes raw product.

## WYOMING.

The only mineral product of much importance in Wyoming is coal, the value of which represents over 90 per cent of the total mineral production. The principal coal-mining operations are at Rock Springs and Sweetwater in Sweetwater County, Cheyenne and Kemmerer in Uinta County, Sheridan, Monarch, and Dietz in Sheridan County, Rawlins in Carbon County, and Gebo in Bighorn County. Other coal-producing counties are Converse, Crook, Fremont, Johnson, Park, and Weston. The total value of all mineral production in Wyoming in 1910 was $12,766,915, of which the coal production, 7,533,088 short tons, represented in value $11,706,187. In 1911 the coal production amounted to 6,744,864 short tons, valued at $10,508,863, and the total mineral production was valued at $11,486,982.

Wyoming, unlike most of the Rocky Mountain States, is not an important producer of any of the metals, the total value of the copper, gold, and silver production in the State being less than $50,000, and the value of all mineral products outside of coal being about $1,000,000. The mineral products which contribute to this are asbestos, clay manufactures, copper, gold, gypsum, iron ore, mineral waters, lime, natural gas, petroleum, phosphate rock, silver, sulphur, sand, and gravel. The development of the extensive phosphate deposits in the southwestern part of the State gives promise of establishing an important industry in the future.

The following table gives the quantity and value of the mineral production of Wyoming during 1910 and 1911:

*Mineral production of Wyoming in 1910 and 1911.*

| Product. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw. | | Derived. | | Raw. | | Derived. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Asbestos..short tons.. | (a) | (a) | | | (a) | (a) | | |
| Clay products..do.... | 532 | b $1,392 | | $50,237 | (a) (b) | (a) (b) | | $77,146 |
| Coal.....do.... | 7,533,088 | 11,706,187 | | | 6,744,864 | $10,508,863 | | |
| Copper.....pounds.. | | | 217,127 | 27,575 | | | 130,499 | 16,312 |
| Gems and precious stones | | | | | | | | 30 |
| Gold, fine ounces (troy) | | | 198 | 4,100 | | | 1,030 | 21,300 |
| Gypsum..short tons.. | 57,163 | | | 150,181 | 44,687 | | | 116,238 |
| Iron ore...long tons.. | 656,629 | 656,629 | | | 479,922 | 479,922 | | |
| Lime.....short tons.. | | | 143 | 1,783 | | | (a) | (a) |
| Mineral waters, gallons sold | (a) | (a) | | | (a) | (a) | | |
| Natural gas | | (a) | | | | (a) | | |
| Petroleum...barrels.. | (a) | (a) | | | (a) | (a) | | |
| Phosphate rock, long tons | (a) | (a) | | | (a) | (a) | | |
| Sand and gravel, short tons | | | | | 784,865 | 58,548 | | |
| Silver, fine ounces (troy) | | | 1,300 | 700 | | | 700 | 400 |
| Stone | | 24,174 | | 24,827 | | (c) | | c 40,544 |
| Sulphur...long tons.. | (a) | (a) | | | (a) | (a) | | |
| Miscellaneous | | 120,522 | | | | d 168,379 | | (d) |
| Total value, eliminating duplications.. | | $12,766,915 | | | | $11,486,982 | | |

a Value included under "Miscellaneous."
b Value not included in total value.
c Derived product includes stone sold rough.
d Derived product included in raw product.

# SUMMARY OF THE MINERAL PRODUCTION OF THE UNITED STATES IN 1911.

Compiled by W. T. Thom.

## GENERAL REMARKS.[1]

The different units of measurement employed in the mineral industry make it impossible to compare the outputs of the several minerals, except in the value of the products.

In 1905, for the first time, and in 1906, for the second time, the total value of the domestic mineral production exceeded the enormous sum of $1,500,000,000; and in 1907 the still greater sum of $2,000,000,000 was exceeded.

In 1908 the disastrous results of the financial depression of the latter part of 1907 became only too apparent in the decrease in value of the mineral output, which declined for the year to about $1,595,000,000 from over $2,000,000,000 in 1907. In 1909 the general recovery in business carried the value of the domestic mineral production up to $1,886,797,179. In 1910 the continued favorable business conditions raised the value again almost to the high level of 1907, the value in 1910 being $1,990,911,135. In 1911 there was a sharp decline in pig iron that brought the total value for the year down to $1,918,326,253, a loss of $72,584,882, or 3.65 per cent, as compared with 1910; a gain of $31,529,074, or 1.67 per cent, over $1,886,797,179 in 1909; a gain over $1,574,572,055 in 1908 of $323,754,198, or 20.56 per cent; and a decrease of $153,429,357, or 7.40 per cent, from $2,071,613,741 in 1907.

As heretofore, iron and coal are the most important of our mineral products. The value of iron (pig iron being the basis of valuation) in 1911 was $327,334,624; the value of coal was $626,366,876. The fuels—coal, natural gas, and petroleum—increased from $828,212,867 in 1910 to $834,538,162 in 1911, a gain of $6,325,295, or 0.76 per cent. Anthracite coal showed an increase in value of $14,914,090 from $160,275,302 in 1910 to $175,189,392 in 1911. The decrease in value of the bituminous coal output from $469,281,719 in 1910 to $451,177,484 in 1911 was $18,104,235, or 3.86 per cent.

The comparative loss in 1911 of $72,584,882 in the total value of our mineral production was due almost entirely to the decrease in pig iron of $84,827,862, the total value for metals showing a decrease of $75,611,118 from $747,790,718 in 1910 to $672,179,600 in 1911.

[1] The imports cited in this summary and in the volume are "imports for consumption," which may or may not be identical with the "total imports" for the calendar year. Merchandise brought into the country late in December, for example, may be entered for consumption or it may be put into a warehouse and not be withdrawn for consumption until some months later. It will then be credited for consumption to the year of its withdrawal from the warehouse.

The nonmetals increased $3,076,236 from $1,242,820,417 in 1910 to $1,245,896,653 in 1911. The unspecified products, including bismuth, cadmium, lithium, selenium, and other minerals, valued at $250,000, a decrease in value of $50,000, bring the total value of the mineral production for 1911 up to $1,918,326,253.

## METALS AND ORES.

*Metals and metallic ores.*—The report on this subject was published for the first time in this series in the volume for 1909. The output of metals in the United States in 1911 from domestic ores was valued at $662,362,192, from foreign sources at $126,562,854, the total value being $788,925,046; the output in 1910 from domestic ores was valued at $723,523,271, from foreign sources at $151,934,355, the total value being $875,657,626, including undistributed. The output of crude metallic ores of all kinds from domestic mines amounted in 1909 to 111,900,807 short tons, in 1910 to 120,367,082 short tons, and in 1911 to 105,258,492 short tons.

*Iron and steel.*—Twenty-two States produced pig iron in 1911 and 1910, against 23 in 1909 and in 1908, and 21 in 1907. The marketed production of pig iron in 1911 was 23,257,288 long tons, valued at $327,334,624, as compared with 26,674,123 long tons, valued at $412,162,486, in 1910, and with 23,162,484 long tons, valued at $418,321,000, the average annual output and value for the five years from 1905 to 1909, inclusive. The production in 1911 showed a decrease in quantity of 3,416,835 long tons, or 12.81 per cent from the production of 1910, and a decrease in value from $412,162,486 to $327,334,624, amounting to $84,827,862, or 20.58 per cent. The average price per long ton of pig iron rose from $19.98 in 1906 to $20.56 in 1907, fell to $15.96 in 1908, rose to $16.25 in 1909, fell to $15.57 in 1910, and to $14.07 in 1911.

The general imports of pig iron in 1911 were valued at $4,755,639. The imports consisted of pig iron, valued at $586,403; scrap, $190,293; ferrochrome, $27,902; ferromanganese, $3,015,602; ferromolybdenum, $11,409; ferrophosphorus, $8,520; ferrosilicon, $341,681; ferrotitanium, $22,500; ferrotungsten, $143,802; ferrovanadium, $2,623; spiegeleisen, $405,444; and in 1910 the imports (including pig iron, valued at $1,487,265; scrap, $925,954; ferrochrome, $79,429; ferromanganese, $4,341,071; ferromolybdenum, $14,402; ferrophosphorus, $5,171; ferrosilicon, $527,157; ferrotitanium, $767; ferrotungsten, $678,534; spiegeleisen, $489,047), were valued at $8,533,628. The exports (including scrap) were valued at $2,489,446 in 1910 and at $2,916,601 in 1911.

*Iron ore.*—The marketed production of iron ore in 1911 amounted to 40,989,808 long tons, valued at the mines at $86,419,830, as compared with 56,889,734 long tons,[1] valued at $140,735,607, in 1910, and with 45,215,336 long tons, valued at $99,865,117, the average yearly production for the five years 1905 to 1909, inclusive. As in the 12 preceding years, the production of iron ore in the United States in 1911 was not equaled by that of any other country. The general imports of iron ore in 1911 were valued at $5,402,636, against $7,832,225 in 1910, and against $3,154,081, the average annual value for the five years from 1905 to 1909. The exports in 1911 were valued at $2,653,448 against $2,474,164 in 1910, and $1,365,325 in 1909.

[1] Production prior to 1911 represents quantity mined.

*Manganese ore.*—The marketed production of manganese ore in 1911 was 2,457 long tons, valued at $24,586, as compared with 2,258 long tons, valued at $22,892, in 1910, as against 1,544 long tons, valued at $19,675, in 1909, and against 5,187 long tons, valued at $55,992, the average annual production for the five preceding years. In addition to the quantity shipped, 1,707 long tons remained in stock at the mines, at the close of 1911, as against 2,321 long tons in stock at the close of 1910. The average price per ton was $12.73 in 1906, $11.31 in 1907, $10.22 in 1908, $12.74 in 1909, $10.14 in 1910, and $10.01 in 1911. Manganiferous ore, carrying from 20 to 40 per cent of manganese, was marketed in 1911 to the extent of 44,437 long tons, valued at $115,918, against 61,101 long tons, valued at $186,765, in 1910, and against 68,654 long tons, valued at $215,925, in 1909. The imports for consumption of manganese ore in 1911 were 176,852 long tons, valued at $1,186,791, against 242,348 long tons, valued at $1,711,131, in 1910, as against 212,765 long tons, valued at $1,405,329, in 1909.

*Gold.*—The production of gold was 4,687,053 fine ounces, valued at $96,890,000, in 1911, as compared with 4,657,018 fine ounces, valued at $96,269,100, in 1910, and with 4,520,389 ounces, valued at $92,804,720, the average annual production for the preceding five-year period.

*Silver.*—The production of silver in 1911 was 60,399,400 fine ounces, valued at $32,615,700, as against 57,137,900 fine ounces, valued at $30,854,500, in 1910, and against 55,259,300 ounces, valued at $33,256,780, the average yearly production for the five years from 1905 to 1909, inclusive.

*Copper.*—The production of copper in 1911 was 1,097,232,749 pounds, valued at $137,154,092, as against 1,080,159,509 pounds, valued at $137,180,257, in 1910, and against 942,221,757 pounds, valued at $151,131,959, the average production for the five-year period ending with 1909. The general imports in 1911 were valued at $38,445,939, as against $40,849,239 in 1910, and $39,642,679 in 1909. The exports in 1911 were valued at $105,679,926, against $96,554,432 in 1910, and $93,919,956, in 1909.

*Lead.*—The production of lead in 1911 was 406,148 short tons, valued at $36,553,320, as compared with 372,227 short tons, valued at $32,755,976, in 1910, with 354,188 tons, valued at $30,460,168, in 1909, and with 327,016 short tons, valued at $31,964,209, the average annual production for the five years next preceding. The imports for consumption of lead were valued at $631,654 in 1911, as against $755,092 in 1910, and $861,506 in 1909. The exports of manufactures of lead were valued at $680,419 in 1911, against $614,158 in 1910, and $509,542 in 1909. The imports of type metal were valued at $310,658 in 1911, at $485,493 in 1910, and at $532,108 in 1909.

*Antimonial lead.*—The production of antimonial lead in 1911 was 14,078 short tons, valued at $1,380,556, as against 14,069 short tons, valued at $1,338,090, in 1910, and 12,896 short tons, valued at $1,231,019 in 1909.

*Zinc.*—The production of zinc in 1911 was 271,621 short tons, valued at $30,964,794, as compared with 252,479 short tons, valued at $27,267,732, in 1910, as compared with 230,225 short tons, valued at $24,864,300, in 1909, and with 200,948 short tons, valued at

$22,283,873, the average annual production for the five-year period ending with 1908. The imports for consumption of zinc, including zinc dust and zinc ores, were valued at $408,273 in 1911, and at $989,795 in 1910; the exports of domestic zinc ore, zinc dust, and manufactures of zinc were valued at $1,935,677 in 1911, at $1,558,271 in 1910, at $1,222,173 in 1909, and at $1,683,887 in 1908.

*Bauxite.*—In 1911 the production of bauxite was 155,618 long tons, valued at $750,649, as compared with 148,932 long tons, valued at $716,258, in 1910, and with 83,717 long tons, valued at $421,955, the average annual production for the five-year period from 1905 to 1909. The imports for consumption in 1911 were 43,222 long tons, valued at $164,301, as against 15,669 long tons, valued at $65,743, in 1910, and 18,688 long tons, valued at $83,956, in 1909.

*Aluminum.*—The consumption of aluminum during 1911 was 46,125,000 pounds, valued at $8,084,000, as against 47,734,000 pounds, valued at $8,955,700, in 1910, and against 17,766,000 pounds, valued at $4,288,600, the annual average consumption for the period from 1905 to 1909. The imports for consumption of aluminum salts in 1911 were valued at $56,833, against $53,671 in 1910 and $29,061 in 1909. The exports of manufactures of aluminum were valued at $1,158,603 in 1911, at $949,215 in 1910, at $567,375 in 1909, and at $330,092 in 1908.

*Quicksilver.*—The production of quicksilver in 1911 amounted to 21,256 flasks, valued at $977,989, as against 20,601 flasks, valued at $958,153, in 1910, and against 21,075 flasks, valued at $957,859, in 1909. California reported 18,860 flasks in 1911, as against 17,211 flasks in 1910 and 16,078 flasks in 1909. Texas and Nevada reported 2,396 flasks, against 3,390 flasks in 1910. No output was reported from Arizona, Oregon, Utah, or Washington in 1911. The imports for consumption were valued at $251,386 in 1911, at $381 in 1910, at $8,203 in 1909, and at $8,216 in 1908. The exports were valued at $13,995 in 1911, at $91,077 in 1910, at $266,243 in 1909, and at $124,960 in 1908.

*Chromic iron ore.*—The production (in California) of chromite in 1911 was 120 long tons, valued at $1,629, as compared with 205 long tons, valued at $2,729, in 1910, and with 598 long tons (California and Wyoming), valued at $8,300, in 1909, with 359 long tons (California and Wyoming), valued at $7,230, in 1908, and with 290 long tons, valued at $5,640, in 1907. The imports for consumption of chrome ore in 1911 were 37,540 long tons, valued at $407,958, against 38,579 long tons, valued at $415,768, in 1910, and 39,624 long tons, valued at $460,758, in 1909; the imports of chrome salts were valued at $3,508 in 1911 and at $21,204 in 1910.

*Molybdenum minerals.*—No production of molybdenum was reported in 1908, 1909, 1910, or 1911. There was a small commercial production in 1907, as in 1906 and 1905. Imports in 1911 were valued at $11,409 and at $14,402 in 1910.

*Nickel.*—The production of nickel in 1908, 1909, and 1910 is included under unspecified products. There was no production of nickel ore reported in 1911, but salts and metallic nickel equivalent to 445 tons of metallic nickel, valued at about $127,000, were saved as by-products, largely from copper refineries. The imports for consumption of nickel in 1911 were valued at $4,050,030, as against

$4,227,838 in 1910, $3,036,273 in 1909, $2,497,585 in 1908, and $2,243,026 in 1907; the exports in 1911 were valued at $8,283,777, as against $4,704,088 in 1910, $4,101,976 in 1909, and $3,297,988 in 1908.

*Cobalt.*—No cobalt was produced in the United States in 1911 or 1910. The imports for consumption were valued at $48,104 in 1911 and at $6,352 in 1910.

*Titanium ore.*—No production of rutile was reported for 1911. A production estimated at $44,480 was reported from Virginia in 1910, against $10,000 in 1909; none was reported in 1908. There was a small output from Virginia in 1907. Imports of ferrotitanium were reported, valued at $22,700 in 1911 and at $767 in 1910.

*Tungsten ore.*—The commercial production of concentrated tungsten ore in 1911 was 1,139 short tons, valued at $407,985, as against 1,821 short tons, valued at 807,307 in 1910, against 1,619 short tons, valued at $614,370 in 1909, and against the average annual production for the five preceding years of 956 short tons, valued at $384,309. The imports for consumption of tungsten ore in 1911 were valued at $85,887, at $344,979 in 1910, and at $105,506 in 1909.

*Uranium and vanadium minerals.*—An output of vanadium from Colorado, New Mexico, and Utah, valued at about $305,500, was reported for 1911; an output was also reported for 1910 as in 1909, but no uranium. No output of either was reported for 1908. Imports for consumption of ferrovanadium valued at $2,623 were reported for 1911. Imports of uranium salts and oxide were valued at $14,106 in 1911, at $10,176 in 1910, and at $12,057 in 1909.

*Tantalum minerals.*—A very small output of tantalum ore was reported as mined in 1911, as in 1910 and 1909; none seems to have been marketed in either year. Tantalum wire was imported for making lamps; value not given.

*Platinum.*—The production of refined platinum from domestic sources in 1911 was 940 ounces, valued at $40,890, as compared with 773 ounces, valued at $25,277, in 1910, and with 638 ounces, valued at $15,950, in 1909, and with 613 ounces, valued at $15,907, the average annual production for the five years ending with 1908. The average price per ounce in 1909 was $24.98, in 1910 it was $32.70, and in 1911 it was $43.50. The imports for consumption of platinum in 1911 were valued at $4,866,207, as against $3,654,664 in 1910 and $2,973,948 in 1909.

*Iridium, osmium, palladium, and rhodium.*—In 1911 imports for consumption of these metals were: Iridium, $210,616; osmium, $25,476; palladium, $56,307—a total of $292,399. In 1910 these imports were: Iridium, $140,232; osmium, $32,647; palladium, $3,570; and rhodium, $4,356—a total of $180,805. The production of these metals from domestic ores in the United States is negligible.

*Antimony.*—No production of antimony has been reported for several years. The imports for consumption of antimony (metal, regulus, and ore) in 1911 were valued at $531,011, as against $539,755 in 1910 and $714,366 in 1909; imports of antimony salts in 1911 were valued at $54,426, as against $14,201 in 1910 and $60,353 in 1909.

*Bismuth.*—The only production of bismuth of any consequence in 1909, 1910, and 1911 has been as a by-product at Grasselli, Ind., and may not be disclosed. There was a small production of bismuth in 1908; no production was reported in 1907. The imports for con-

sumption in 1911 were valued at $311,771, as against $332,668 in 1910 and $286,516 in 1909.

*Tin.*—In 1911 the output of tin ore was equivalent to 66 short tons of metallic tin, valued at $56,635, as compared with a production valued at $23,447 in 1910. The imports of tin for consumption in 1911 were valued at $43,346,394, as against $33,913,255 in 1910, against $27,558,546 in 1909, $23,923,560 in 1908, and $32,074,263 in 1907.

*Cadmium.*—Cadmium was produced by the Grasselli Chemical Co., of Cleveland, Ohio, in 1906; there was a production also in 1907, 1908, 1909, and 1910; in 1911 there were two producers. The imports for consumption of cadmium were valued at $3,870 in 1911 against $2,295 in 1910, $4,559 in 1909, $2,390 in 1908, $1,633 in 1907, and $10,522 in 1906.

*Selenium and tellurium.*—There was a small output of selenium in 1911, as in 1910 and 1909. Selenium is recovered in the anode mud or slime of the electrolytic copper refineries, particularly at Baltimore, Md., and at Perth Amboy, and Chrome, N. J. Tellurium is found combined in large quantities with gold and silver at Cripple Creek, Colo., in smaller quantities at other mining camps of the West, and also in the mud or slime of electrolytic copper refineries.

## FUELS.

*Coal.*—In 1906 the production of coal in the United States exceeded 400,000,000 tons; in 1910, four years later, it exceeded half a billion tons, but fell a little short of this maximum in 1911. The output in 1911 was 496,221,168 short tons, valued at $626,366,876, as against 501,596,378 short tons, valued at $629,557,021 in 1910, and against 432,780,130 short tons, valued at $538,279,696, the average production for the five-year period from 1905 to 1909. Of this total, the output of anthracite coal in 1911 was 80,771,488 long tons, valued at $175,189,392, as compared with 75,433,246 long tons, valued at $160,275,302 in 1910, an increase in value in 1911 as compared with 1910 of $14,914,090. The average price of the anthracite coal actually sold during the 1911 season at the mine was $2.17 per long ton, against $2.12 in 1910 and $2.06 in 1909.

The output of bituminous coal (which includes semianthracite and all semibituminous and lignite coals) amounted in 1911 to 405,757,101 short tons, valued at $451,177,484, as compared with 417,111,142 short tons, valued at $469,281,719, in 1910. The decrease in the production of bituminous coal in 1911 from 1910 was, therefore, 11,354,041 short tons, or 2.72 per cent, in quantity and $18,104,235, or 3.86 per cent, in value. The average price of bituminous coal per ton at the mines in 1911 was $1.11, as against $1.12 in 1910. The imports for consumption of anthracite in 1911 were valued at $12,550, against $42,244 in 1910; the imports of bituminous were valued at $3,604,797, against $4,761,223 in 1910, against $3,628,533 in 1909 and $3,964,843 in 1908. The exports were in 1911, anthracite, $18,093,285; bituminous, $34,499,989; in 1910, anthracite, $14,785,387; bituminous, $26,685,405.

*Coal briquets.*—The production of coal briquets in the United States in 1911 was 218,443 short tons, valued at $808,721, as compared with 139,661 short tons, valued at $452,697 in 1909. The production was not reported in 1910.

*Coke.*—The production of coke in 1911 amounted to 35,551,489 short tons (7,847,845 tons from retort ovens), valued at $84,130,849, as against 41,708,810 short tons (7,138,734 tons from retort ovens), valued at $99,742,701 in 1910, against 39,315,065 short tons (6,254,644 tons from retort ovens), valued at $89,065,483 in 1909; and against 31,821,307 short tons, valued at $72,850,456, the average for the five years from 1904 to 1908.

The average price per ton in 1911 was $2.37, against $2.39 in 1910, against $2.29 in 1909, and $2.40 in 1908. The average output from the by-product ovens in 1911 was 1,817 short tons per oven, against 1,762 short tons per oven in 1910 and 1,598 short tons per oven in 1909. The average output from beehive ovens in 1911 was 468 short tons per oven, against 376 tons per oven in 1910 and 361 short tons per oven in 1909. The imports for consumption of coke were valued at $254,455 in 1911, against $625,130 in 1910 and $736,120 in 1909. The exports were valued at $3,215,990 in 1911, against $3,053,293 in 1910 and $3,232,673 in 1909.

*Natural gas.*—The value of natural gas produced in 1911 was $74,127,534, as compared with $70,756,158 in 1910, with $63,206,941 in 1909, and with $47,199,264, the average annual value for the preceding five-year period. No imports of natural gas were reported for 1911 and 1910, as against $6,060 in 1909 and $22,003 in 1908.

*Petroleum.*—The total production of crude petroleum in 1911 was 220,449,391 barrels, valued at $134,044,752, as against 209,557,248 barrels, valued at $127,899,688 in 1910 and against 179,801,018 barrels, valued at $110,809,311, the average annual production for the years 1905 to 1909. The average price for crude petroleum per barrel in 1911 was 60.8 cents, against 61 cents in 1910. The imports for consumption of petroleum in 1911 were valued at $2,410,884, as against $1,398,861 in 1910. The exports in 1911 were valued at $105,922,848, as against $94,107,022 in 1910.

The imports for consumption of ozokerite and paraffin in 1911 were valued at $792,818, as against $1,025,829 in 1910. The exports of paraffin and paraffin wax were valued in 1911 at $7,047,856, against $7,329,143 in 1910, against $7,608,624 in 1909, and against an average annual value of $8,348,043 for the years from 1904 to 1908.

*Peat.*—The commercial production of peat in 1911, chiefly in the form of peat fertilizer filler and peat food for stock, was valued at $272,114, against $140,209 in 1910. The imports of peat-moss litter have averaged about $40,000 for the last six years.

## STRUCTURAL MATERIALS.

*Cement.*—The total production of hydraulic cement in the United States in 1911 was 79,547,958 barrels, valued at $66,705,136, as compared with 77,785,141 barrels, valued at $68,752,092 in 1910, with 66,689,715 barrels, valued at $53,610,563 in 1909, and with 45,583,855 barrels, valued at $43,529,447, the annual average production for the years 1904 to 1908. The Portland cement production in 1911 was 78,528,637 barrels, valued at $66,248,817, as compared with 76,549,951 barrels, valued at $68,205,800 in 1910. The production of natural cement in 1911 was 926,091 barrels, valued at $378,533, as compared with 1,139,239 barrels, valued at $483,006 in 1910. The production of puzzolan cement in 1911 amounted to 93,230 barrels, valued at

$77,786, as against 95,951 barrels, valued at $63,286 in 1910. The imports for consumption of hydraulic cement in 1911 were valued at $242,722, as compared with $395,526 in 1910. The exports were valued at $4,632,215 in 1911, against $3,477,981 in 1910.

*Clay products.*—The value of all clay products in 1911, as reported to the Survey, was $162,236,181, as compared with $170,115,974 in 1910, and with $153,838,171, the average annual value for the five preceding years. The pottery products were valued at $34,518,560 in 1911, as against $33,784,678 in 1910. The imports for consumption of pottery in 1911 amounted to $10,638,616, as against $11,131,158 in 1910. The imports of brick in 1911 were valued at $166,133, against $206,613 in 1910. The exports of brick in 1911 were valued at $2,264,354, against $1,602,913 in 1910, and the exports of pottery at $1,401,366, against $1,041,689 in 1910. The imports of kaolin or china clay in 1911 were valued at $1,461,068, as against $1,593,472 in 1910. The imports of other clays amounted to $235,254 in 1911, against $320,891 in 1910.

*Glass sand.*—The production of glass sand in 1911 was 1,538,666 short tons, valued at $1,543,733, as compared with 1,461,089 short tons, valued at $1,516,711 in 1910, and with $1,172,912, the average annual value for the period from 1905 to 1909.

*Gypsum.*—The output of crude gypsum in 1911 was 2,323,970 short tons, valued in its first marketable condition at $6,462,035, as compared with 2,379,057 short tons, valued at $6,523,029, in 1910, and with an annual average value of $4,358,406 for the five years from 1905 to 1909.

The greatly increased production of late years is attributable to the largely increased use of wall plaster and of plaster of Paris in large modern buildings. The imports for consumption in 1911 were valued at $450,806, against $502,111 in 1910 and $425,137 in 1909.

*Lime.*—The production of lime in 1911 was 3,392,887 short tons, valued at $13,688,970, against 3,505,954 short tons, valued at $14,088,039 in 1910, and against $12,203,259, the average annual value for the years 1905 to 1909. The average price per short ton was $4.03 in 1911, against $4.02 in 1910. The imports for consumption in 1911 were 5,232 short tons, valued at $55,255, against 6,498 short tons, valued at $63,791, in 1910. The exports reported in 1911 were valued at $153,212, as against $127,952 in 1910.

*Sand and gravel.*—The production of sand for molding, building, engine, furnace, and other uses and of gravel reported in 1911 was 65,308,273 short tons, valued at $19,614,850, as against 67,949,347 short tons, valued at $19,520,919 in 1910. The imports for consumption of sand in 1911 were valued at $147,268, as compared with $133,757 in 1910.

*Sand-lime brick.*—The production of sand-lime brick in 1911 was valued at $897,664, as against $1,169,153 in 1910, and against $1,109,625, the average value for the five-year period from 1905 to 1909.

*Slate.*—The production of slate in 1911 was valued at $5,728,019, against $6,236,759 in 1910 and against $5,792,402, the average annual value for the period 1905 to 1909. The imports of slate in 1911 were valued at $8,367, against $4,127 in 1910. The exports of roofing slate were not reported separately in 1911 or in 1910; in 1909 they were valued at $209,383 and at $197,216 in 1908.

*Stone.*—The value of all kinds of stone produced in the United States in 1911 amounted to $77,108,567, as compared with $76,520,584 in 1910; the annual average value for the period 1905 to 1909 was $67,868,209. The imports for consumption of marble and stone were valued in 1911 at $1,556,398, against $1,569,143 in 1910, and the exports at $1,810,182, against $1,538,339 in 1910.

Included under stone is the limestone used for fluxing in blast furnaces, which in 1911 was 16,126,650 long tons, valued at $7,987,208, as compared with 18,203,882 long tons, valued at $9,345,733 in 1910, against 15,772,863 long tons, valued at $7,921,807 in 1909, and against an average production of 14,066,574 long tons, valued at $6,873,891 for the years 1904 to 1908.

## ABRASIVE MATERIALS.

*Artificial abrasives.*—The total production of the artificial abrasives, alundum, carborundum, and crushed steel in 1911 amounted to 21,292,000 pounds, valued at $1,493,040, as against 23,027,000 pounds, valued at $1,604,030, in 1910.

*Corundum and emery.*—No domestic corundum was reported in 1909, 1910, or 1911. The output of emery was 659 short tons, valued at $6,778 in 1911, as against 1,028 short tons, valued at $15,077, in 1910, and against an average annual value of the combined production of corundum and emery for the five years ending in 1909 of $28,999. The imports for consumption were valued in 1911 at $336,644, at $629,758 in 1910, and at $338,997 in 1909.

*Garnet.*—The production of abrasive garnet during 1911 amounted to 4,076 short tons, valued at $121,748, as against 3,814 short tons, valued at $113,574 in 1910 and against $136,742, the annual average value for the years 1905 to 1909.

*Grindstones.*—The total value of all kinds of grindstones and pulp stones produced in 1911 was $907,316, as against $796,294 in 1910 and against $751,734, the average annual value for the period 1905 to 1909. The imports were valued at $123,727 in 1911, at $106,596 in 1910, and at $99,153 in 1909.

*Infusorial earth and tripoli.*—The value of the infusorial earth and tripoli production in 1911 was $147,462 against $130,006 in 1910, and against $92,068, the average annual value for the years 1905 to 1909. The imports for consumption of rotten stone and tripoli were valued at $35,665 in 1911, at $56,657 in 1910, and at $24,024 in 1909.

*Millstones and burrstones.*—The value of the production of millstones and burrstones in 1911 was $40,069, as against $28,217 in 1910, $35,393 in 1909, and as against $37,413, the annual average for the five preceding years. The imports for consumption were valued at $36,028 in 1911, at $34,763 in 1910, and at $22,590 in 1909.

*Oilstones and whetstones.*—The production of oilstones and whetstones in 1911 was valued at $214,991, as against $228,694 in 1910, $214,019 in 1909, and against the average annual value of $236,615 for the five years 1904 to 1908. The imports for consumption were valued at $54,379 in 1911, at $45,819 in 1910, and at $68,018 in 1909.

*Pumice.*—The production of pumice amounted to 21,689 short tons, valued at $88,399 in 1911, against 23,271 short tons, valued at $94,943 in 1910, and against 15,103 short tons, valued at $33,439, in 1909. The imports for consumption were valued at $118,977 in 1911, at $104,425 in 1910, and at $100,997 in 1909.

## CHEMICAL MATERIALS.

*Arsenious oxide.*—The domestic production of arsenious oxide (white arsenic) in 1911 amounted to 6,264,000 pounds, valued at $73,408, as against 2,994,000 pounds, valued at $52,305 in 1910. The imports for consumption of white arsenic, metallic arsenic, and arsenic sulphide in 1911 were valued at $247,323, as against $314,306 in 1910.

*Borax.*—The reported returns for 1911 gave an aggregate production of crude borax of 53,330 short tons, valued at $1,569,151, as against 42,357 short tons, valued at $1,201,842, in 1910, and against $1,166,489, the average annual value from 1905 to 1909. The imports for consumption of borax in 1911 were valued at $23,628, against $12,397 in 1910.

*Bromine.*—The production of bromine in 1911 amounted to 651,541 pounds, valued at $110,902, as compared with 245,437 pounds, valued at $31,684, in 1910.

*Calcium chloride.*—The production of calcium chloride in 1911 was 14,606 short tons, valued at $91,215, as against 10,971 short tons, valued at $74,713, in 1910.

*Fluorspar and cryolite.*—The commercial production of fluorspar in 1911 was 87,048 short tons, valued at $611,447, as compared with 69,427 short tons, valued at $430,196, in 1910, and with 47,439 short tons, valued at $282,320, the average production for the years 1905 to 1909. The imports for consumption in 1909 were 6,971 short tons, valued at $26,377; in 1910 they were 42,488 short tons, valued at $135,152; and in 1911 they were 32,764 short tons, valued at $80,592. The imports of cryolite in 1911 were valued at $47,093, as against $2,343 in 1910.

*Lithium minerals.*—No production of lithium minerals was reported in 1911; the production in 1910 was small, as in 1909, and the figures may not be published.

*Phosphate rock.*—The total commercial production of phosphate rock reported to the Survey in 1911 amounted to 3,053,279 long tons, valued at $11,900,693, as compared with 2,654,988 long tons, valued at $10,917,000 in 1910, and with $9,638,396, the average annual value for the years 1905 to 1909. The total quantity of phosphate rock reported as mined during 1911 was 3,102,415 long tons, as against 2,626,794 long tons mined in 1910. The imports for consumption of crude phosphate, guano, kainite, manure salts, etc., in 1911 were valued at $10,387,588, as against $9,254,607 in 1910. The exports of phosphate rock in 1911 were 1,246,577 long tons, valued at $9,235,388, as against 1,083,037 long tons, valued at $8,234,276, in 1910.

*Potash salts.*—There was no actual production of potash salts in the United States in 1911. Search for potash salts was carried on by the United States Geological Survey by deep drilling for saline residues, by the collection and examination of natural and artificial brines and bitterns, by the examination of deposits of alunite and other minerals containing potassium, and the examination of certain occurrences of igneous rocks known to contain large quantities of potash. Besides the work of the Survey, the systematic study of the seaweeds or kelps of the Pacific coast as a source of potash has been taken up by the Bureau of Soils of the Department of Agriculture, which has also undertaken a field survey of the desert basins of the

arid States of the West in search of fertilizer materials. The imports of potash salts in 1911 were valued at $9,892,324, as compared with $6,668,018 in 1910.

*Salt.*—The salt product includes salt in the form of brine used in large quantities for the manufacture of soda ash, sodium bicarbonate, caustic soda, and other sodium salts. The domestic production of salt in 1911 amounted to 31,183,968 barrels of 280 pounds, valued at $8,345,692, as compared with 30,305,656 barrels, valued at $7,900,344 in 1910, and with $7,252,012, the value of the average annual output 1905 to 1909. The imports for consumption in 1911 were valued at $375,030, against $370,922 in 1910. The exports in 1911 were valued at $335,285, as against $320,926 in 1910.

*Sodium nitrate.*—The imports of sodium nitrate for consumption in manufacture of fertilizers and other chemical products amounted in value in 1911 to $16,814,268, as compared with $16,601,343 in 1910.

*Sulphur and pyrite.*—The domestic production of sulphur in 1911 was 265,664 long tons, valued at $4,787,049, as against 255,534 long tons, valued at $4,605,112, in 1910, and against 275,538 long tons, valued at $5,009,274, the average annual production for the years 1905 to 1909. The production of pyrite in 1911 was 301,458 long tons, valued at $1,164,871, as against 241,612 long tons, valued at $977,978, in 1910, and against 246,295 long tons, valued at $910,003, the average annual production for the five years 1905 to 1909. The imports for consumption of sulphur fell in value from $558,611 in 1910 to $552,836 in 1911. The exports in 1911 amounted to 28,103 long tons, valued at $545,420, as against 30,742 long tons, valued at $552,941, in 1910. The imports for consumption of pyrite were valued at $3,788,803 in 1911, $2,748,647 in 1910, and at $2,428,580 in 1909.

*Sulphuric acid from copper and zinc smelters.*—The production of sulphuric acid from the fumes of copper and zinc smelters was reported for the first time in 1911. It amounted to 438,300 short tons (60° Baumé), valued at $2,733,696.

## PIGMENTS.

*Barytes.*—The production of crude barytes in 1911 was 38,445 short tons, valued at $122,792, as compared with 42,975 short tons, valued at $121,746, in 1910, with 61,945 short tons, valued at $209,737, in 1909, and with 58,468 short tons, valued at $179,269, the average annual production for the five years from 1904 to 1908. The imports for consumption of barytes were valued at $58,726 in 1911, against $78,239 in 1910. The imports of barium compounds were valued at $398,213 in 1911, against $470,449 in 1910.

*Cobalt oxide.*—The production of cobalt oxide in 1908 and 1909 is included under unspecified products. No production was reported for 1910 or 1911. A production was reported from Oregon and Missouri in 1907. No production was reported in 1905 and 1906. The imports for consumption in 1911 were valued at $48,104, as against $6,352 in 1910.

*Mineral paints.*—The commercial production of mineral paints in 1911 amounted to 143,350 short tons, valued at $7,842,583 (zinc oxide being included), as compared with the production (zinc oxide being excluded) of 85,685 short tons, valued at $2,174,735, in 1910; with

78,771 short tons, valued at $2,373,805, in 1909; with 69,244 short tons, valued at $2,367,723, in 1908; and with 75,566 short tons, valued at $2,984,935, in 1907.

*Zinc oxide.*—The production of zinc oxide in 1911 may not be separately reported; it amounted to 58,481 short tons, valued at $5,238,945, in 1910, as compared with 68,974 short tons, valued at $6,156,755, in 1909, and with 66,944 short tons, valued at $5,578,243, the average production for the years 1904 to 1908. The imports for consumption of zinc oxide in 1911 were valued at $357,466, as against $396,573 in 1910. The exports were valued in 1911 at $1,051,311, as against $943,968 in 1910.

## MISCELLANEOUS.

*Asbestos.*—The asbestos commercially produced in the United States in 1911 was obtained from deposits in Vermont, Georgia, Virginia, and Wyoming. The total commercial production in 1911 was 7,604 short tons, valued at $119,935, as against 3,693 short tons, valued at $68,357, in 1910, and against 1,896 short tons, valued at $33,133, the annual average production for 1905 to 1909. The imports for consumption were valued at $1,703,639 in 1911, as against $1,543,248 in 1910.

*Asphalt.*—Under this title are included the various bitumens or hydrocarbons not discussed elsewhere under the heading "Petroleum." The commercial production in 1911 was 360,004 short tons, valued at $3,828,751, compared with 260,080 short tons, valued at $3,080,067, in 1910, and with 180,845 short tons, valued at $1,812,227, the average production for the five preceding years. The imports of asphalt in 1911 were valued at $789,236, as against $785,963 in 1910 and $633,205 in 1909. The exports for 1911 were valued at $598,930, as against $702,520 for 1910.

*Feldspar.*—The production of feldspar in 1911 was 92,700 short tons, valued at $579,008, as against 81,102 short tons, valued at $502,452, in 1910, and against 76,539 short tons, valued at $424,602, in 1909.

*Fertilizers.*—Fertilizers, including apatite, bone dust, guano, kainite, kieserite, crude phosphates, and other manures, are reported under phosphate rock and under potash salts.

*Fuller's earth.*—As reported to the Survey, the production of fuller's earth in 1911 was 40,697 short tons, valued at $383,124, as against 32,822 short tons, valued at $293,709, in 1910, and against an average annual production for the years 1905 to 1909 of 30,654 short tons, valued at $270,328. The imports for consumption were valued at $143,594 in 1911 and at $132,545 in 1910.

*Gems and precious stones.*—The value of gems and precious stones found in the United States in 1911 was reported at $343,692, as against $295,797 in 1910 and $534,380 in 1909. Pearls produced in 1907 were valued at $264,500, as against $381,000 in 1906. No production of pearls was reported for 1908, 1909, 1910, or 1911. Imports of precious stones in 1911 were valued at $40,820,436, as against $40,704,487 in 1910, against $40,237,509 in 1909, and against an annual average value of $30,648,792 for the years 1904 to 1908.

*Graphite.*—The commercial production of crystalline graphite during 1911 amounted to 4,790,000 pounds, valued at $256,050, as

compared with 5,590,592 pounds, valued at $295,733, in 1910, and with $218,579, the average annual value for the period from 1905 to 1909. The production of amorphous graphite in 1911 was 1,233 short tons, valued at $32,415, as compared with 1,407 short tons, valued at $39,710, in 1910, and with $83,225, the average value for the period from 1905 to 1909. The production of manufactured graphite in 1911 was 10,144,000 pounds, valued at $664,000, the average price being 6.55 cents per pound, as compared with 13,149,100 pounds, valued at $945,000, the average price being 7.2 cents per pound, in 1910. The average annual value for the preceding five years was $421,018. The imports for consumption of graphite in 1911 were valued at $1,495,729, as against $1,872,592 in 1910, $1,854,459 in 1909, and $762,367 in 1908.

*Magnesite.*—The production of crude magnesite continues to be limited to California. During 1911 the commercial production was 9,375 short tons, valued at $75,000, as against 12,443 short tons, valued at $74,658, in 1910, and against 7,070 short tons, valued at $23,782, the average for 1905 to 1909. The imports for consumption of magnesite and magnesia in 1911 were valued at $1,224,987, as against $1,578,683, in 1910.

*Mica.*—The total production of mica in 1911 was 1,887,201 pounds of sheet mica, valued at $310,254, and 3,512 short tons of scrap mica, valued at $45,550, as against 2,476,190 pounds of sheet mica, valued at $283,832, and 4,065 short tons of scrap mica, valued at $53,265, in 1910, and against annual values for the years 1905 to 1909 of $246,159 for sheet mica and of $32,669 for scrap mica. The imports of mica in 1911 were valued at $502,163, as against $724,525 in 1910.

*Mineral waters.*—The total production of mineral waters in 1911 was 63,923,119 gallons, valued at $6,837,888, as compared with 62,030,125 gallons, valued at $6,357,590, in 1910, with 64,674,486 gallons, valued at $6,894,134, in 1909, and with the average production of 48,910,285 gallons, valued at $6,956,539, for the years 1904 to 1908. The imports for consumption of mineral waters in 1911 were valued at $1,037,485, as against $983,136 in 1910.

*Monazite and zircon.*—No production of monazite was reported for 1911. In 1910 the production was 99,301 pounds of concentrates, valued at $12,006, as against 543,931 pounds of concentrates, valued at $65,032, in 1909; 422,646 pounds of concentrates, valued at $50,718, in 1908; and 548,152 pounds of concentrates, valued at $65,800, in 1907. The imports for consumption of thorium nitrate in 1911 were 121,111 pounds, valued at $238,841, as against 124,808 pounds, valued at $219,615, in 1910; 127,833 pounds, valued at $236,057, in 1909; and 65,289 pounds, valued at $173,239, in 1908. The imports of monazite and thorium oxide in 1911 were valued at $60,542, as against $48,199 in 1910 and $27,920 in 1909.

The production of zircon in 1909 was 2,000 pounds, valued at $250. No production was reported in 1910. In 1911 the production amounted to 3,208 pounds, valued at $802.

*Quartz.*—The production of quartz in 1911 was 87,943 short tons, valued at $155,122, as compared with 63,577 short tons, valued at $193,757, in 1910, as compared with 135,469 short tons, valued at $249,466, in 1909; with 47,316 short tons, valued at $190,157, in 1908; and with 33,192 short tons, valued at $223,801, in 1907. The value

of the unground flint stones imported for consumption in 1911 was $236,158, as against $307,286 in 1910.

*Talc and soapstone.*—Exclusive of the production of fibrous talc from Gouverneur, N. Y., the production of talc and soapstone in 1911 amounted to 81,521 short tons, valued at $1,032,732, as compared with 79,006 short tons, valued at $864,213, in 1910, and with 60,086 short tons, valued at $796,460, the average annual production for the five-year period from 1905 to 1909. The imports for consumption of talc in 1911 were valued at $88,050, as against $106,460 in 1910, and $56,287 in 1909.

*Fibrous talc.*—This variety of talc or soapstone occurs in but one locality in the United States—Gouverneur, St. Lawrence County, N. Y. It is used principally as makeweight in the manufacture of paper. In 1911 the production was 62,030 short tons, valued at $613,286, as against 71,710 short tons, valued at $728,180, in 1910, and against 61,049 short tons, valued at $537,109, the average annual production for the years 1905–1909.

## MINERAL PRODUCTS OF THE UNITED STATES IN 1910 AND 1911, BY SUBSTANCES.

From the following tabular statement headed "Mineral products of the United States in 1910 and 1911," all unnecessary duplication has been excluded. The manufactured coke product, amounting in 1911 to 35,551,489 short tons, and valued at $84,130,849, is excluded, as the quantity and value of the coal used in its manufacture are included in the statistics of coal production. Similarly, white lead, red lead, lithopone, Venetian red, litharge, and orange mineral, whose average aggregate value for the last 10 years has largely exceeded $15,000,000, are not given in the table, the base from which they are made being included in the output of pig lead. Zinc white or zinc oxide, zinc-lead, sublimed blue lead, and sublimed white lead, on the other hand, made directly from the ores, and consequently not included in zinc or lead production, are tabulated. The production of pig iron and its value are given in the table as the best means of presenting the statistics of the production of iron in the first marketable condition, the value of iron ores being excluded. Similarly, the value of the products of the clay industries is given as being the first marketable condition of the greater part of the clay produced, although the production and value of the clay mined and sold in the raw state by clay miners to manufacturers of clay are elsewhere shown separately, but are not included in the tabular statement, in order to avoid duplication.

The figures for gold and silver for 1910 and 1911 are the official figures agreed upon by the United States Geological Survey and the Director of the Mint since 1905, inclusive. The figures for the tonnage (not the value) of pig iron up to 1909, inclusive, are from the reports of Mr. James M. Swank, general manager of the American Iron & Steel Association.

| | Product. | 1910. | | 1911. | | Increase (+) or decrease (−) in 1911. | | Percentage of increase (+) or decrease (−) in 1911. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | METALS. | | | | | | | | |
| 1 | Pig iron [a] (spot value [b]), long tons (2,240 lbs.) | 26,674,123 | $412,162,486 | 23,257,288 | $327,334,624 | − 3,416,835 | −$84,827,862 | − 12.81 | − 20.58 |
| 2 | Silver, commercial value [c] ....troy ounces | 57,137,900 | 30,854,500 | 60,399,400 | 32,615,700 | + 3,261,500 | + 1,761,200 | + 5.71 | + 5.71 |
| 3 | Gold, coining value [d] .....do | 4,657,018 | 96,269,100 | 4,687,053 | 96,890,000 | + 30,035 | + 620,900 | + .64 | + .64 |
| 4 | Copper [e], value at New York City, pounds | 1,080,159,509 | 137,180,257 | 1,097,232,749 | 137,154,092 | +17,073,240 | − 26,165 | + 1.58 | − .02 |
| 5 | Lead [e], value at New York City, short tons (2,000 lbs.) | 372,227 | 32,755,976 | 406,148 | 36,553,320 | + 33,921 | + 3,797,344 | + 9.11 | + 11.59 |
| 6 | Zinc [e], value at St. Louis .....short tons | 252,479 | 27,267,732 | 271,621 | 30,964,794 | + 19,142 | + 3,697,062 | + 7.58 | + 13.56 |
| 7 | Quicksilver, value at San Francisco, flasks (75 lbs. net) | 20,601 | 958,153 | 21,256 | 977,989 | + 655 | + 19,836 | + 3.18 | + 2.07 |
| 8 | Aluminum (consumption) .....pounds | 47,734,000 | 8,955,700 | 46,125,000 | 8,084,000 | − 1,609,000 | − 871,700 | − 3.37 | − 9.73 |
| 9 | Antimony [f] .....short tons | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 10 | Antimonial lead .....do | 14,069 | 1,338,090 | 14,078 | 1,380,556 | + 9 | + 42,466 | + .06 | + 3.17 |
| 11 | Nickel [g], value at New York City, pounds | ..... | ..... | 890,000 | 127,000 | + 890,000 | + 127,000 | ..... | ..... |
| 12 | Tin .....pounds | ..... | 23,447 | ..... | 56,635 | ..... | + 33,188 | ..... | +141.54 |
| 13 | Platinum, value at New York City, troy ounces | 773 | 25,277 | 940 | 40,890 | + 167 | + 15,613 | + 21.60 | + 61.77 |
| 14 | Total value of metals | ..... | 747,790,718 | ..... | 672,179,600 | ..... | − 75,611,118 | ..... | − 10.11 |
| | NONMETALS (spot value *b*). | | | | | | | | |
| 15 | Bituminous coal [h] .....short tons | 417,111,142 | 469,281,719 | 405,757,101 | 451,177,484 | −11,354,041 | − 18,104,235 | − 2.72 | − 3.86 |
| 16 | Pennsylvania anthracite .....long tons | 75,433,246 | 169,275,302 | 80,771,488 | 175,189,392 | + 5,338,242 | + 14,914,090 | + 7.08 | + 9.31 |
| 17 | Natural gas ..... | ..... | 70,756,158 | ..... | 74,127,534 | ..... | + 3,371,376 | ..... | + 4.76 |
| 18 | Petroleum .....barrels (42 gals.) | 209,557,248 | 127,899,688 | 220,449,391 | 134,044,752 | +10,892,143 | + 6,145,064 | + 5.20 | + 4.80 |

*a* Production of iron ore—1910: 56,889,734 long tons; value at mines, $140,735,607; 1911: 40,989,808 long tons; value at mines, $86,419,830.
*b* By "spot" value is meant value at the point of production.
*c* Average price per troy ounce in 1910 was 54 cents; in 1911 it was 53 cents.
*d* Prior to 1905, coining value, $20.6718 per troy ounce; in 1905, coining value, $20.671834; since 1905, coining value, $20.671834625323.
*e* The product from domestic ores only.
*f* Includes antimony smelted from imported ores, and also antimony contained in hard lead, before 1907.
*g* Includes nickel in copper-nickel alloy and in exported ore and matte.
*h* Including brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania. Coke, 1910: 41,708,810 short tons; value at ovens, $99,742,701; 1911: 35,551,489 short tons; value at ovens, $84,130,849.

*Mineral products of the United States in 1910 and 1911*—Continued.

| | Product. | 1910. | | 1911. | | Increase (+) or decrease (−) in 1911. | | Percentage of increase (+) or decrease (−) in 1911. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | NONMETALS (spot value)—Continued. | | | | | | | | |
| 19 | Peat | | $140,209 | | $272,114 | | + $131,905 | | + 94.08 |
| 20 | Clay products[a] | | 170,115,974 | | 162,236,181 | | − 7,879,793 | | − 4.63 |
| 21 | Cement, barrels (380 lbs. net) | 77,785,141 | 68,752,692 | 79,547,958 | 66,705,136 | + 1,762,817 | − 2,046,956 | + 2.27 | − 2.98 |
| 22 | Glass sand, short tons | 1,461,089 | 1,516,711 | 1,538,666 | 1,543,733 | + 77,577 | + 27,022 | + 5.31 | + 1.78 |
| 23 | Gypsum, do | 2,379,057 | 6,523,029 | 2,323,970 | 6,462,035 | − 55,087 | − 60,994 | − 2.32 | − .93 |
| 24 | Lime, do | 3,505,954 | 14,088,039 | 3,392,915 | 13,689,054 | − 113,039 | − 398,985 | − 3.22 | − 2.83 |
| 25 | Sand (molding, building, etc.) and gravel, short tons | 67,949,347 | 19,520,919 | 65,308,273 | 19,614,850 | − 2,641,074 | + 93,931 | − 3.89 | + .48 |
| 26 | Sand-lime brick | | 1,169,153 | | 897,664 | | − 271,489 | | − 23.22 |
| 27 | Slate | | 6,236,759 | | 5,728,079 | | − 508,740 | | − 8.16 |
| 28 | Stone[b] | | 76,520,584 | | 77,108,567 | | + 587,983 | | + .77 |
| 29 | Corundum and emery, short tons | 1,028 | 15,077 | 659 | 6,778 | − 369 | − 8,299 | − 35.89 | − 55.04 |
| 30 | Abrasive quartz and feldspar, do | | (c) | | (c) | | | | |
| 31 | Garnet, abrasive, do | 3,814 | 113,574 | 4,076 | 121,748 | + 262 | + 8,174 | + 6.87 | + 7.20 |
| 32 | Grindstones | | 796,294 | | 907,316 | | + 111,022 | | + 13.94 |
| 33 | Infusorial earth and tripoli, short tons | | 130,006 | | 147,462 | | + 17,456 | | + 13.43 |
| 34 | Millstones | | 28,217 | | 40,069 | | + 11,852 | | + 42.00 |
| 35 | Oilstones, etc | | 228,694 | | 214,991 | | − 13,703 | | − 5.99 |
| 36 | Pumice, short tons | 23,271 | 94,943 | 21,687 | 88,399 | − 1,582 | − 6,544 | − 6.80 | − 6.89 |
| 37 | Arsenious oxide, pounds | 2,994,000 | 52,305 | 6,264,000 | 73,408 | + 3,270,000 | + 21,103 | +109.22 | + 40.35 |
| 38 | Borax, crude, short tons | 42,357 | 1,201,842 | 53,330 | 1,569,151 | + 10,973 | + 367,309 | + 25.91 | + 30.56 |
| 39 | Bromine, pounds | 245,487 | 31,684 | 651,541 | 110,902 | + 406,104 | + 79,218 | +165.46 | +250.02 |
| 40 | Calcium chloride, short tons | 10,971 | 74,713 | 14,606 | 91,215 | + 3,635 | + 16,502 | + 33.13 | + 22.09 |
| 41 | Fluorspar, do | 69,427 | 430,196 | 87,048 | 611,447 | + 17,621 | + 181,251 | + 25.38 | + 42.13 |
| 42 | Lithium minerals, do | | (d) | | (d) | | | | |
| 43 | Marls, do | | | | | | | | |
| 44 | Phosphate rock, long tons | 2,654,988 | 10,917,000 | 3,053,279 | 11,900,693 | + 398,291 | + 983,693 | + 15.00 | + 9.01 |
| 45 | Pyrite, do | 241,612 | 977,978 | 301,458 | 1,164,871 | + 59,846 | + 186,893 | + 24.77 | + 19.11 |
| 46 | Sulphur, do | 255,534 | 4,605,112 | 265,664 | 4,787,049 | + 10,130 | + 181,937 | + 3.96 | + 3.95 |
| 47 | Sulphuric acid (60° Baumé, from copper and zinc smelters), short tons | | | 438,300 | 2,733,696 | + 438,300 | + 2,733,696 | | |
| 48 | Salt, barrels (280 lbs. net) | 30,305,656 | 7,900,344 | 31,183,968 | 8,345,692 | + 878,312 | + 445,348 | + 2.90 | + 5.64 |
| 49 | Barytes, crude, short tons | 42,975 | 121,746 | 38,445 | 122,792 | − 4,530 | + 1,046 | − 10 54 | + .86 |
| 50 | Cobalt oxide, pounds | | | | | | | | |
| 51 | Mineral paints[e], short tons | 85,394 | 2,141,654 | 143,350 | 7,842,583 | − 435 | + 461,984 | − .30 | + 6.26 |
| 52 | Zinc oxide, do | 58,481 | 5,238,945 | | | | | | |
| 53 | Asbestos, do | 3,693 | 68,357 | 7,604 | 119,935 | + 3,911 | + 51,578 | +105.90 | + 75.45 |
| 54 | Asphalt, do | 260,080 | 3,080,067 | 360,004 | 3,828,751 | + 99,924 | + 748,684 | + 38.42 | + 24.31 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 55 | Bauxite.....long tons.. | 148,932 | 716,258 | 155,618 | 750,649 | + 6,686 | + 34,391 | + 4.49 | + 4.80 |
| 56 | Chromic iron ore.....do.... | 205 | 2,729 | 120 | 1,629 | − 85 | − 1,100 | − 41.46 | − 40.31 |
| 57 | Feldspar.....short tons.. | 81,102 | 502,452 | 92,700 | 579,008 | + 11,598 | + 76,556 | + 14.30 | + 15.24 |
| 58 | Fuller's earth.....do.... | 32,822 | 293,709 | 40,697 | 383,124 | + 7,875 | + 89,415 | + 23.99 | + 30.44 |
| 59 | Gems and precious stones..... | ..... | 295,797 | ..... | 343,692 | ..... | + 47,895 | ..... | + 16.19 |
| 60 | Graphite.....{crystalline, pounds..... | 5,590,592 | 295,733 | 4,790,000 | 256,050 | − 800,592 | − 39,683 | − 14.32 | − 13.42 |
| | Graphite.....{amorphous, short tons.. | 1,407 | 39,710 | 1,223 | 32,415 | − 184 | − 7,295 | − 13.08 | − 18.37 |
| 61 | Magnesite.....short tons.. | 12,443 | 74,658 | 9,375 | 75,000 | − 3,068 | + 342 | − 24.66 | + .46 |
| 62 | Manganese ore.....long tons.. | 2,258 | 22,892 | 2,457 | 24,586 | + 199 | + 1,694 | + 8.81 | + 7.40 |
| 63 | Manganiferous ore.....do.... | 61,101 | 186,765 | 44,437 | 115,918 | − 16,664 | − 70,847 | − 27.27 | − 37.93 |
| 64 | Mica.....{sheet, pounds..... | 2,476,190 | 283,832 | 1,887,201 | 310,254 | − 588,989 | + 26,422 | − 23.79 | + 9.31 |
| | Mica.....{scrap, short tons.. | 4,065 | 53,265 | 3,512 | 45,550 | − 553 | − 7,715 | − 13.11 | − 14.48 |
| 65 | Mineral waters.....gallons sold.. | 62,030,125 | 6,357,590 | 63,923,119 | 6,837,888 | + 1,892,994 | + 480,298 | + 3.05 | + 7.55 |
| 66 | Quartz.....short tons.. | 63,577 | 193,757 | 87,943 | 155,122 | + 24,366 | − 38,635 | + 38.33 | − 20.00 |
| 67 | Talc and soapstone.....do.... | 79,006 | 864,213 | 81,521 | 1,032,732 | + 2,515 | + 168,519 | + 3.18 | + 19.50 |
| 68 | Talc, fibrous.....do.... | 71,710 | 728,180 | 62,030 | 613,286 | − 9,680 | − 114,894 | − 13.50 | − 15.78 |
| 69 | Thorium minerals (monazite) and zircon, pounds..... | 99,301 | 12,006 | 3,208 | 802 | − 96,093 | − 11,204 | − 96.77 | − 93.32 |
| 70 | Titanium ore (rutile).....pounds.. | 1,132,000 | 44,480 | ..... | ..... | − 1,132,000 | − 44,486 | −100.00 | −100.00 |
| 71 | Tungsten ore.....short tons.. | 1,821 | 807,307 | 1,139 | 407,985 | − 682 | − 399,322 | − 37.45 | − 49.46 |
| 72 | Uranium and vanadium minerals....do.... | ..... | (*d*) | ..... | 305,500 | ..... | + 305,500 | ..... | ..... |
| 73 | Total value of nonmetals..... | ..... | 1,242,820,417 | ..... | 1,245,896,653 | ..... | + 3,076,236 | ..... | + .25 |
| 74 | Total value of metals..... | ..... | 747,790,718 | ..... | 672,179,600 | ..... | − 75,611,118 | ..... | − 10.11 |
| 75 | Estimated value of mineral products unspecified *d*..... | ..... | 300,000 | ..... | 250,000 | ..... | − 50,000 | ..... | − 16.67 |
| 76 | Grand total..... | ..... | 1,990,911,135 | ..... | 1,918,326,253 | ..... | − 72,584,882 | ..... | − 3.65 |

*a* Value of clay mined and sold as unmanufactured clay—1910: $3,625,485; 1911: $3,480,763.

*b* Includes limestone for iron flux, but not grindstones.

*c* Included under feldspar and quartz.

*d* Includes nitrate of soda, carbonate of soda, sulphate of soda, and alum clays used by paper manufacturers; and bismuth, cadmium, lithium, and selenium, valued together in 1911 at about $103,000.

*e* Includes since 1904 metallic paint, mortar colors, ocher, umber, sienna, shale, ground slate; since 1907, also sublimed blue lead, sublimed white lead, zinc-lead, and leaded zinc oxide; since 1910, also whiting; in 1911, also zinc oxide.

## TOTAL VALUE OF MINERAL PRODUCTS OF THE UNITED STATES FROM 1880 TO 1911.

The following table and diagram show the value, year by year, of the mineral products of the United States as reported to the United States Geological Survey from 1880 to 1911, inclusive:

*Total value of mineral products of the United States from 1880 to 1911, by years.*

| Year. | Metals. | Nonmetals. | Unspecified products. | Total. |
|---|---|---|---|---|
| 1880 | $185,649,163 | $173,279,135 | $6,000,000 | $364,928,298 |
| 1881 | 187,549,908 | 206,783,144 | 6,500,000 | 400,833,052 |
| 1882 | 214,061,009 | 231,340,150 | 6,500,000 | 451,901,159 |
| 1883 | 196,547,259 | 243,812,214 | 6,500,000 | 446,859,473 |
| 1884 | 179,230,899 | 221,879,506 | 5,000,000 | 406,110,405 |
| 1885 | 172,491,087 | 241,312,093 | 5,000,000 | 418,803,180 |
| 1886 | 203,249,225 | 230,088,769 | 800,000 | 434,137,994 |
| 1887 | 236,598,254 | 270,989,420 | 800,000 | 508,387,674 |
| 1888 | 237,574,422 | 286,150,114 | 900,000 | 524,624,536 |
| 1889 | 247,768,701 | 282,623,812 | 1,000,000 | 531,392,513 |
| 1890 | 292,649,877 | 312,826,503 | 1,000,000 | 606,476,380 |
| 1891 | 282,617,183 | 321,767,846 | 1,000,000 | 605,385,029 |
| 1892 | 281,514,539 | 340,028,842 | 1,000,000 | 622,543,381 |
| 1893 | 219,436,649 | 323,257,318 | 1,000,000 | 543,693,967 |
| 1894 | 185,804,594 | 362,570,173 | 1,000,000 | 549,374,767 |
| 1895 | 245,874,431 | 393,897,097 | 1,000,000 | 640,771,528 |
| 1896 | 251,445,519 | 388,098,702 | 1,000,000 | 640,544,221 |
| 1897 | 265,209,975 | 380,782,607 | 1,000,000 | 646,992,582 |
| 1898 | 305,482,183 | 417,790,671 | 1,000,000 | 724,272,854 |
| 1899 | 487,831,631 | 525,524,074 | 1,000,000 | 1,014,355,705 |
| 1900 | 511,632,891 | 594,398,501 | 1,000,000 | 1,107,031,392 |
| 1901 | 480,006,859 | 660,850,112 | 1,000,000 | 1,141,856,971 |
| 1902 | 599,916,009 | 722,027,126 | 1,000,000 | 1,322,943,135 |
| 1903 | 583,433,948 | 905,242,380 | 1,000,000 | 1,489,676,328 |
| 1904 | 502,149,624 | 859,543,144 | 400,000 | 1,362,092,768 |
| 1905 | 700,418,946 | 921,727,456 | 400,000 | 1,622,546,402 |
| 1906 | 886,110,856 | 1,017,700,525 | 200,000 | 1,904,011,381 |
| 1907 | 903,802,244 | 1,167,711,497 | 100,000 | 2,071,613,741 |
| 1908 | 549,923,116 | 1,044,398,939 | 250,000 | 1,594,572,055 |
| 1909 | 753,496,439 | 1,133,000,740 | 300,000 | 1,886,797,179 |
| 1910 | 747,790,718 | 1,242,820,417 | 300,000 | 1,990,911,135 |
| 1911 | 672,179,600 | 1,245,896,653 | 250,000 | 1,918,326,253 |
| Grand total | 12,769,447,758 | 17,670,119,680 | 55,200,000 | 30,494,767,438 |

## IMPORTS AND EXPORTS.

The following table shows the value for the calendar years 1910 and 1911 of the imports for consumption and of the exports of the mineral products included in this report as furnished by the Bureau of Foreign and Domestic Commerce of the Department of Commerce and Labor. As has been noted elsewhere, "imports for consumption" may or may not be identical with "total imports" for the calendar year. Thus, total imports valued at $500,000 may all be entered for consumption, or $50,000 of these imports may be entered in bond and be reported for consumption in the following calendar year. These differences tend to equalize. Thus in the five years from 1903 to 1907, inclusive, the general imports of iron ores exceeded the imports for consumption by less than 7,500 long tons in total imports of over 4,603,000 tons. The difference for a single year may, however, be considerable.

The imports of nonmetallic products increased in value $4,036,188, or 3.36 per cent, from $120,110,557 in 1910 to $124,146,745 in 1911, and the exports increased $26,303,886, or 15.99 per cent, from $164,-

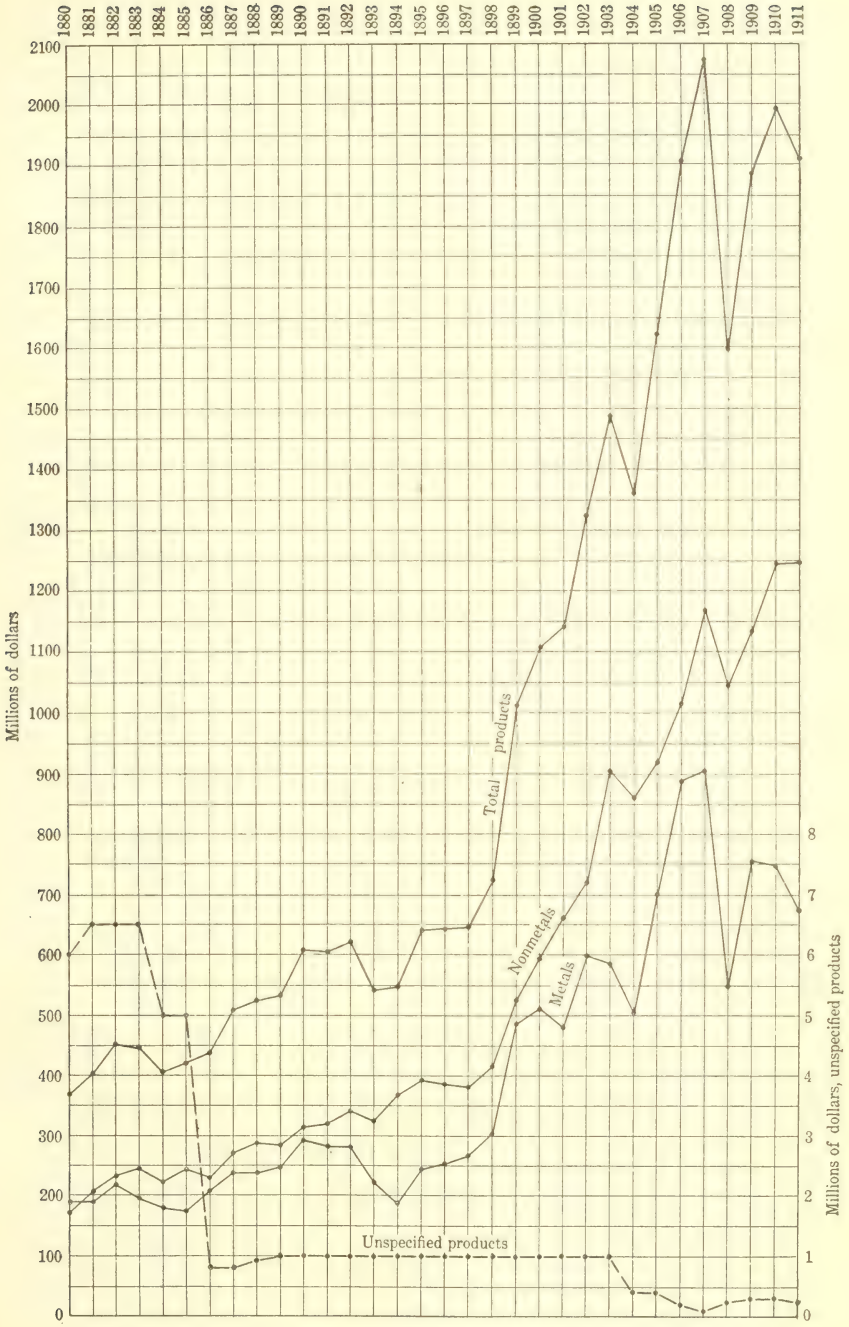



FIGURE 1.—Value of mineral products in the United States, 1880–1911.

503,755 in 1910 to $190,807,641 in 1911. The total imports of mineral products, metals and nonmetals, increased $4,710,642, or 2.09 per cent, and the total exports in 1911 increased $40,591,481, or 14.84 per cent; the exports of metals increased about $13,888,000, or 12.69 per cent, and the exports of nonmetals increased about $26,000,000, or 15.99 per cent. Copper constituted about 76 per cent of the metallic exports, and petroleum and its derivatives about 60 per cent of the nonmetallic exports. Copper constituted about 36 per cent and tin about 41 per cent of the imported metals; gems and precious stones made up about 33 per cent and fertilizers almost 30 per cent of the nonmetallic imports.

*Value of imports for consumption and of exports of mineral products in the calendar years 1910 and 1911.*

METALS.

| Product. | 1910 | 1911 |
|---|---|---|
| IMPORTS. | | |
| Aluminum salts | $53,671 | $56,833 |
| Antimony (metal, regulus, and ore) | 539,755 | 531,011 |
| Antimony salts | 14,201 | 54,426 |
| Bauxite | 65,743 | 164,301 |
| Bismuth | 332,668 | 311,771 |
| Cadmium | 2,295 | 3,870 |
| Chromic iron ore | 415,768 | 407,958 |
| Chromium salts | 21,204 | 3,508 |
| Cobalt (oxide, ore, and zaffer) | 6,352 | 48,104 |
| Copper, in ore, matte, ingots, bars, manufactures, etc | 40,849,239 | 38,445,939 |
| Iron ore | 7,832,225 | 5,402,636 |
| Pig iron (including scrap) | 2,413,219 | 776,696 |
| Ferrochrome | 79,429 | 27,902 |
| Ferromanganese | 4,341,071 | 3,015,062 |
| Ferromolybdenum | 14,402 | 11,409 |
| Ferrophosphorus | 5,171 | 8,520 |
| Ferrosilicon | 527,157 | 341,681 |
| Ferrotitanium | 767 | 22,700 |
| Ferrotungsten | 678,534 | 143,802 |
| Ferrovanadium | | 2,623 |
| Spiegeleisen | 489,047 | 405,444 |
| Lead, in ore, base bullion, pigs, sheets, manufactures, etc | 755,092 | 631,654 |
| Manganese ore | 1,711,131 | 1,186,791 |
| Nickel, in ore, matte, oxide, etc | 4,227,838 | 4,050,030 |
| Platinum | 3,654,664 | 4,866,207 |
| Quicksilver | 381 | 251,386 |
| Tin | 33,913,255 | 43,346,394 |
| Tungsten ore | 344,979 | 85,887 |
| Type metal | 485,493 | 310,658 |
| Uranium salts and oxide | 10,176 | 14,106 |
| Zinc, in ore, pigs, sheets, dust, manufactures, etc | 989,795 | 408,273 |
| Iridium, osmium, palladium, and rhodium | 180,805 | 292,399 |
| Total | 104,955,527 | 105,629,981 |
| Increase | | 674,474 |
| Percentage of increase | | 0.64 |
| EXPORTS. | | |
| Aluminum and manufactures, etc | 949,215 | 1,158,603 |
| Copper, in ore, matte, ingots, bars, manufactures, etc | 96,554,432 | 105,679,926 |
| Iron ore | 2,474,164 | 2,653,448 |
| Pig iron (including scrap) | 2,489,446 | 2,916,601 |
| Lead, in ore, base bullion, pigs, sheets, manufactures, etc | 614,158 | 680,419 |
| Nickel, in ore, matte, oxide, etc | 4,704,088 | 8,283,777 |
| Quicksilver | 91,077 | 13,995 |
| Zinc, in ore, pigs, sheets, dust, manufactures, etc | 1,558,271 | 1,935,677 |
| Total | 109,434,851 | 123,322,446 |
| Increase | | 13,887,595 |
| Percentage of increase | | 12.69 |

*Value of imports for consumption and of exports of mineral products in the calendar years 1910 and 1911*—Continued.

NONMETALS.

| Product. | 1910 | 1911 |
|---|---|---|
| IMPORTS. | | |
| Alizarin | $430,393 | $996,794 |
| Aniline salts | 501,369 | 410,193 |
| Arsenic sulphides, etc | 314,306 | 247,323 |
| Asbestos | 1,543,248 | 1,703,639 |
| Asphalt | 785,963 | 789,236 |
| Barytes | 78,239 | 58,726 |
| Barium compounds | 470,449 | 398,213 |
| Borax | 12,397 | 23,628 |
| Burrstones and millstones | 34,763 | 36,028 |
| Cement, hydraulic | 395,526 | 242,722 |
| Clay | 320,891 | 235,254 |
| Clay products: | | |
| Brick and tile, etc | 206,613 | 166,133 |
| Pottery, etc | 11,131,158 | 10,638,616 |
| Coal: | | |
| Anthracite | 42,244 | 12,550 |
| Bituminous | 4,761,223 | 3,604,797 |
| Coal-tar products | 7,423,815 | 8,235,891 |
| Cobalt | 6,352 | 48,104 |
| Coke | 625,130 | 254,455 |
| Corundum and emery | 629,758 | 336,644 |
| Cryolite | 2,343 | 47,093 |
| Fertilizers: | | |
| Crude (guano, kainite, manure salts, phosphates, etc.) | 9,254,607 | 10,387,588 |
| Potassium chloride | 5,252,272 | 7,651,693 |
| Potassium sulphate | 1,415,746 | 2,240,631 |
| Sodium nitrate | 16,601,343 | 16,814,268 |
| Flint and flint pebbles | 307,286 | 236,158 |
| Fluorspar | 135,152 | 80,592 |
| Fuller's earth | 132,545 | 143,594 |
| Gems and precious stones | 40,704,487 | 40,820,436 |
| Granite | 176,912 | 146,468 |
| Graphite | 1,872,592 | 1,495,729 |
| Grindstones | 106,596 | 123,727 |
| Gypsum | 502,111 | 450,806 |
| Hones, oilstones, whetstones | 45,819 | 54,379 |
| Infusorial earth and rotten stone | 56,657 | 35,665 |
| Kaolin or china clay | 1,593,472 | 1,461,068 |
| Lead paints—litharge, orange mineral, red lead, white lead | 106,118 | 118,395 |
| Lime | 63,791 | 55,255 |
| Magnesite and magnesia | 1,578,683 | 1,224,987 |
| Marble and stone | 1,392,231 | 1,409,930 |
| Mica | 724,525 | 502,163 |
| Mineral waters | 983,136 | 1,037,485 |
| Monazite and thorium oxide | 48,199 | 60,542 |
| Ocher | 131,846 | 110,932 |
| Peat | 41,938 | 39,372 |
| Petroleum | 1,398,861 | 2,410,884 |
| Ozokerite and paraffin | 1,025,829 | 792,818 |
| Pumice | 104,425 | 118,977 |
| Pyrite | 2,748,647 | 3,788,803 |
| Salt | 370,922 | 375,030 |
| Sand and gravel | 133,757 | 147,268 |
| Sienna and umber | 76,872 | 59,334 |
| Slate | 4,127 | 8,367 |
| Strontium oxide | 23 | ..... |
| Sulphur | 558,611 | 552,836 |
| Talc | 106,460 | 88,050 |
| Thorium nitrate | 219,615 | 238,841 |
| Venetian red | 21,591 | 20,169 |
| Zinc oxide | 396,573 | 357,466 |
| Total | 120,110,557 | 124,146,745 |
| Increase | ..... | 4,036,188 |
| Percentage of increase | ..... | 3.36 |
| Grand total imports | 225,066,084 | 229,776,726 |
| Increase | ..... | 4,710,642 |
| Percentage of increase | ..... | 2.09 |

*Value of imports for consumption and of exports of mineral products in the calendar years 1910 and 1911*—Continued.

NONMETALS—continued.

| Product. | 1910 | 1911 |
|---|---|---|
| EXPORTS. | | |
| Asphalt | [a] $702,520 | [a] $598,930 |
| Cement, hydraulic | 3,477,981 | 4,632,215 |
| Clay products: | | |
| Brick and tile, etc. | 1,602,913 | 2,264,354 |
| Pottery, etc. | 1,041,689 | 1,401,366 |
| Coal: | | |
| Anthracite | 14,785,387 | 18,093,285 |
| Bituminous | [b] 26,685,405 | [b] 34,499,989 |
| Coke | 3,053,293 | 3,215,990 |
| Fertilizers, phosphates, crude | 8,234,276 | 9,235,388 |
| Lime | 127,952 | 153,212 |
| Marble and stone | 1,538,339 | 1,810,182 |
| Petroleum | 94,107,022 | 105,922,848 |
| Paraffin and paraffin wax | 7,329,143 | 7,047,856 |
| Salt | 320,926 | 335,285 |
| Sulphur | 552,941 | 545,420 |
| Zinc oxide | 943,968 | 1,051,311 |
| Total exports | 164,503,755 | 190,807,641 |
| Increase | | 26,303,886 |
| Percentage of increase | | 15.99 |
| Grand total exports | 273,538,606 | 314,130,087 |
| Increase | | 40,591,481 |
| Percentage of increase | | 14.84 |

[a] Asphalt and manufactures of, fiscal year.
[b] Not including bunker coal laden as fuel in vessels in the foreign trade, which aggregated in value $20,737,407 in 1910 and $21,473,111 in 1911; reported separately by Bureau of Statistics.

If gold and silver are included, for the sake of rounding out the metals mentioned in this report, the metallic imports decreased from $210,056,213 in 1910 to $206,821,736 in 1911, and the metallic exports increased from $225,570,646 in 1910 to $226,170,166 in 1911; the total imports increased from $330,166,770 in 1910 to $330,968,481 in 1911, and the total exports increased from $390,074,401 in 1910 to $416,977,807 in 1911. The movements of gold and silver, however, are rather financial than commercial; nevertheless the following table is added to show the results mentioned above:

*Value of imports for consumption and of exports of mineral products in the calendar years 1910 and 1911, including gold and silver.*

| Product. | 1910 | 1911 |
|---|---|---|
| IMPORTS. | | |
| Gold (ore, bullion, and coin) | $59,222,518 | $57,445,184 |
| Silver (ore, bullion, and coin) | 45,878,168 | 43,746,571 |
| Other metals | 104,955,527 | 105,629,981 |
| Total | 210,056,213 | 206,821,736 |
| Total metals | 210,056,213 | 206,821,736 |
| Total nonmetals | 120,110,557 | 124,146,745 |
| Grand total | 330,166,770 | 330,968,481 |
| EXPORTS. | | |
| Gold (ore, bullion, and coin) | 58,774,822 | 37,183,074 |
| Silver (ore, bullion, and coin) | 57,360,973 | 65,664,646 |
| Other metals | 109,434,851 | 123,322,446 |
| Total | 225,570,646 | 226,170,166 |
| Total metals | 225,570,646 | 226,170,166 |
| Total nonmetals | 164,503,755 | 190,807,641 |
| Grand total | 390,074,401 | 416,977,807 |

# METALS AND METALLIC ORES IN 1910 AND 1911.

By H. D. McCaskey.

## INTRODUCTION.

For the calendar years 1908 and 1909 the Survey published a summary, by Waldemar Lindgren, of the domestic production of metals—divided into output from domestic and from foreign sources and measured for uniformity throughout by the short ton of 2,000 pounds—and of the domestic output of metallic ores by classes, measured also by the short ton. For purposes of comparison and contrast this summary filled a need not otherwise supplied, and similar data are here given for 1910 and 1911.

In the detailed chapters on the various metals in Part I of Mineral Resources of the United States (to which the reader should refer for full information on the metallic resources and industries), the production is measured in terms of the customary unit, whether the long ton of 2,240 pounds, the metric ton of 2,204.6 pounds, the short ton of 2,000 pounds, the "flask" of 75 pounds, the avoirdupois pound, or the troy ounce. The long ton is used for coal, iron ore, bauxite, pig iron, and steel, particularly in the Eastern States, and for tin, copper, and spelter in England. The metric ton is used on the continent of Europe, in Mexico, and wherever the metric system is in vogue. The "flask" is the customary unit for the measurement of quicksilver except where the metric ton is used; the avoirdupois pound is the unit referred to in defining the tons and the "flask," and is also used for measuring the output of copper, lead, spelter, aluminum, nickel, etc.; the short ton is used for both ore and concentrates in the West, as well as for lead and spelter; and the troy ounce is used for gold, silver, and platinum and allied rare metals. Were the metric system in commercial use in the United States, this confusion of terms would be avoided; in its absence the production of this country by metal mines and metallurgical plants is summarized, as stated, in terms of the short ton of 2,000 pounds.

The table of metal production gives in the main the output from plants—mills, smelters, refineries—in the United States, and is essentially a measure of the metallurgical industry, for the supplies of ore, matte, unrefined bullion, etc., treated in this country are from both domestic and foreign sources. The attempt is made at subdivision of these two, however, and the production in marketable form of metals from both domestic and foreign mines is therefore given wherever possible. The table of domestic ore production is a measure of the metal-mining industry of the United States alone.

There are, roughly, four stages to be considered in the production of metal in marketable form from crude ore: (1) Mining, (2) milling and concentrating, (3) smelting, and (4) refining. The first stage produces crude ore; and both straight concentrating and gold and silver milling plants produce concentrates. Both crude ore and concentrates are treated in both gold and silver amalgamating, cyaniding, and chlorinating plants, and also in smelters, and the products

are refined in private refineries and the precious metals in part in the United States mints. As production may be reported, therefore, as metal in raw materials, in unrefined state, or as refined, there may be three sets of figures to represent the metal output, and there may be certain discrepancies between these for the same metal for the same calendar year, owing to time difference, customary losses in metallurgical operations, and difference in activity between mining and treating the ore. In this summary the metals are measured as refined.

## METALS.

The following tables show the production of metals in the United States in 1910 and 1911:

*Production of metals in the United States in 1910 and 1911, in short tons.*

1910.

| Metal. | Production from domestic ores. | | Production from foreign ores, matte, and unrefined bullion smelted or refined in the United States. | | Total production. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Iron (pig) | 29,875,018 | $390,241,936 | [a] 1,590,000 | $21,920,550 | 30,328,632 | $412,162,486 |
| Manganese (spiegeleisen and ferromanganese) | ..... | ..... | [b] 251,363 | 6,988,921 | 251,363 | 6,988,921 |
| Nickel | ..... | ..... | 16,025 | 4,085,074 | 16,025 | 4,085,074 |
| Aluminum | [c] 23,867 | 8,955,700 | ..... | ..... | 23,867 | 8,955,700 |
| Gold | 159.669 | 96,269,100 | 42.143 | 24,868,231 | 201.812 | 121,137,331 |
| Silver | 1,959.014 | 30,854,466 | 2,394.044 | 37,706,188 | 4,353.058 | 68,560,654 |
| Platinum | .027 | 25,277 | .164 | 156,960 | .191 | 182,237 |
| Quicksilver | 772.537 | 958,153 | ..... | ..... | 772.537 | 958,153 |
| Tin | 21 | 15,187 | 28 | 9,401 | 49 | 24,588 |
| Copper, stated as refined | 535,947 | 136,130,538 | [d] 47,393<br>[e] 127,680 | 12,037,822<br>32,430,720 | 711,020 | 180,599,080 |
| Lead, stated as refined | 361,827 | 31,840,776 | [f] 76,905<br>[g] 31,648 | 6,767,640<br>2,785,024 | 470,380 | 41,393,440 |
| Antimonial lead | 10,140 | 964,406 | 3,929 | 373,684 | 14,069 | 1,338,090 |
| Zinc, stated as spelter | 252,479 | 27,267,732 | 16,705 | 1,804,140 | 269,184 | 29,071,872 |
| Total | ..... | 723,523,271 | ..... | 151,934,355 | ..... | [h] 875,657,626 |

1911.

| | | | | | | |
|---|---|---|---|---|---|---|
| Iron (pig) | 24,980,035 | $313,334,558 | 1,068,127 | $14,000,066 | 26,048,162 | $327,334,624 |
| Manganese (spiegeleisen and ferromanganese) | 97,894 | 1,662,810 | 102,155 | 3,083,731 | 200,049 | 4,746,541 |
| Other ferro-alloys [i] | 83,281 | 2,630,186 | 450 | 1,001,105 | 83,731 | 3,631,291 |
| Nickel [j] | ..... | ..... | ..... | ..... | ..... | ..... |
| Aluminum | [c] 23,063 | 8,084,000 | ..... | ..... | 23,063 | 8,084,000 |
| Gold | 160.699 | 96,890,000 | 30.005 | 18,091.080 | 190.704 | 114,981,080 |
| Silver | 2,070.837 | 32,615.700 | 2,389.454 | 36,936,965 | 4,460.291 | 69,552,665 |
| Platinum | .032 | 40,890 | .967 | 1,267,590 | .999 | 1,308,480 |
| Quicksilver | 797.100 | 977,989 | ..... | ..... | 797.100 | 977,989 |
| Tin | 5 | 4,226 | ..... | ..... | 5 | 4,226 |
| Copper, stated as refined | 550,635 | 137,658,750 | [d] 49,300<br>[e] 117,002 | 12,325,000<br>29,250,500 | 716,937 | 179,234,250 |
| Lead, stated as refined | 406,148 | 36,553,320 | [f] 64,991<br>[g] 29,143 | 5,849,190<br>2,622,870 | 500,282 | 45,025,380 |
| Antimonial lead | 9,636 | 944,969 | 4,442 | 435,587 | 14,078 | 1,380,556 |
| Zinc, stated as spelter | 271,621 | 30,964,794 | 14,905 | 1,699,170 | 286,526 | 32,663,964 |
| Total | ..... | 662,362,192 | ..... | 126,562,854 | ..... | 788,925,046 |

[a] Estimated, 1910.
[b] Includes domestic.
[c] Includes foreign. Figures are consumption, not production.
[d] From foreign ores and matte.
[e] From foreign blister copper.
[f] From foreign ores.
[g] From foreign base bullion..
[h] Includes value of domestic output of vanadium, etc., 1910.
[i] Includes ferrosilicon, ferrophosphorus, ferrovanadium, ferrotungsten, ferromolybdenum, ferrotitanium.
[j] Figures not available.

*Pig iron.*—The production of pig iron is usually reported by long tons. The output of 1910 was 26,674,123 long tons and for 1911 it was 23,257,288 long tons.

*Manganese (spiegeleisen and ferromanganese).*—The figures for the important iron-manganese alloys were formerly published by the Survey combined with those of pig iron. Statistics for their total marketed production are now available separately. The production for both alloys is given as 226,216 long tons in 1910 and 178,615 long tons in 1911.

*Ferrosilicon and ferrophosphorus.*—The combined marketed production of ferrosilicon and ferrophosphorus was 62,647 long tons in 1910 and 70,122 long tons in 1911.

*Other ferro-alloys.*—In addition to spiegeleisen, ferromanganese, ferrosilicon, and ferrophosphorus are the ferro-alloys known as ferromolybdenum, ferrotitanium (with 10 to 20 per cent of titanium), ferrovanadium, ferrotungsten (with about 50 per cent of tungsten). Figures for the total marketed production of these are not available for 1910, but the combined output in 1911 was 4,638 long tons.

*Nickel.*—The production of nickel in the United States from domestic ores is merely a by-product, mainly from electrolytes of the copper refineries. Salts and metal equivalent to 445 short tons of metallic nickel were reported saved in domestic refineries in 1911 from both foreign and domestic ores. The figures for 1910 given in the table are for content of nickel in ore and matte "imported for consumption" and are practically all from the Canadian (Sudbury) deposits. The corresponding figures for 1911 are not available.

*Aluminum.*—There is only one producer of aluminum in the United States. The figures given are those for consumption. The statistics are usually reported in pounds and show 47,734,000 pounds for 1910 and 46,125,000 pounds for 1911.

*Gold and silver.*—The production of gold and silver is usually given in fine ounces troy. The following table gives the output of domestic plants for 1910 and 1911:

*Production of gold and silver in 1910 and 1911, in fine ounces troy.*

| | Year. | Domestic. | Foreign. | Total. |
|---|---|---|---|---|
| Gold | 1910 | 4,657,018 | 1,229,168 | 5,886,186 |
| | 1911 | 4,687,053 | 875,156 | 5,562,209 |
| Silver | 1910 | 57,137,900 | 69,826,274 | 126,964,174 |
| | 1911 | 60,399,400 | 69,692,387 | 130,091,787 |

The unrefined foreign gold and silver come mainly from Canada and Mexico, and considerable ore from which gold and silver are by-products of the smelters in base bullion is also received by domestic plants chiefly from these countries.

*Platinum.*—The production is usually reported in troy ounces and the domestic output is from crude platinum from gravels in Oregon and California, and from refined metal as a by-product in refining gold and copper bullion from both domestic and foreign ores, and bullion from scrap. The figures are 390 and 1,000 troy ounces, respectively, for 1910, and 628 and 1,200 troy ounces, respectively, for 1911.

*Quicksilver.*—The domestic production of quicksilver is entirely from domestic ores and is usually reported in flasks of 75 pounds each The output was 20,601 flasks in 1910 and 21,256 flasks in 1911.

*Tin.*—The production of tin is usually given in short tons. The small domestic output from domestic sources is from stream tin in Alaska and tin ore in Texas. The consumption in the United States is largely supplied by imports, but also by recoveries of secondary tin from old metal. American tin ore is partly smelted in England.

*Copper.*—The domestic copper production is usually reported as blister copper in pounds. The output of blister copper from domestic ores was 1,080,159,509 pounds in 1910 and 1,097,232,749 pounds in 1911. Foreign sources for copper produced and refined in the United States are Mexico, Canada, Peru, Europe, and other countries.

*Lead.*—The production of lead is usually given in short tons. The imports of foreign material for treatment in domestic plants come mainly from Mexico.

*Antimonial lead.*—The output of antimonial lead is mainly a metallurgical by-product obtained in refining lead bullion.

*Zinc.*—The production of metallic zinc or spelter is usually stated in short tons. The figures do not include zinc in pigments. Imports of foreign ores come mainly from Mexico.

## METALLIC ORES.

The following table shows the production of crude metallic ores supplied from domestic mines to gold and silver mills, concentrating plants, and smelters:

*Production of crude metallic ores from domestic mines in 1910 and 1911, in short tons.*

| | 1910 | 1911 |
|---|---|---|
| Iron ores | 63,716,502 | 45,908,585 |
| Manganese ores | 2,529 | 2,752 |
| Manganiferous iron ores | 5,971 | 3,006 |
| Chromium ores | 230 | 134 |
| Tungsten ores | 20,000 | 16,500 |
| Titanium ores | 8,000 | ..... |
| Aluminum ores | 166,804 | 174,292 |
| Gold ores | 9,111,415 | 9,884,684 |
| Silver ores | 534,879 | 739,200 |
| Quicksilver ores | 123,502 | 138,525 |
| Tin ores | 8,800 | 42,200 |
| Vanadium and uranium ores | ..... | 8,468 |
| Copper ores: | | |
| Western States | 16,853,637 | 18,207,566 |
| Central States | 10,869,561 | 10,978,827 |
| Eastern States | 774,040 | 801,842 |
| Total | 28,497,238 | 29,988,235 |
| Lead ores: | | |
| Western States | 2,081,545 | 2,157,817 |
| Central States | 3,693,523 | 3,794,712 |
| Eastern States | 6,400 | ..... |
| Total | 5,781,468 | 5,952,529 |
| Zinc and zinc-lead ores: | | |
| Western States | 824,078 | 1,356,781 |
| Central States | 11,154,285 | 10,629,269 |
| Eastern States | 411,381 | 413,332 |
| Total | 12,389,744 | 12,399,382 |
| Grand total | 120,367,082 | 105,258,492 |

*Iron ore.*—Under iron ores are included 625,670 short tons of manganiferous iron ores (with low manganese content) in 1910 and 535,270 short tons in 1911 shipped from Lake Superior mines. The Lake Superior and Clinton hematites are usually shipped without concentration, although there is a movement now growing important to

wash and concentrate some Lake ores. The eastern brown ores are usually washed to remove clay. The magnetites of New York are in part concentrated to remove apatite. All these ores are reported in the table as shipped or smelted.

*Manganese ores.*—The production of high-grade manganese ore is mainly from Virginia, but the figures given include some output from Arkansas in 1910 and from California in 1911. The principal uses of manganese ores are for the manufacture of iron-manganese alloys, as fluxes in smelting, as oxidizing and decolorizing agents, for making dry cells, and for coloring glass, brick, and pottery.

*Manganiferous iron ore.*—The low-grade manganiferous iron ores from the Lake Superior region are included with iron ores in the table. The remaining manganiferous iron ores come mainly from Arkansas and Virginia, and are used chiefly in making high-manganese pig iron. Considerable quantities of manganiferous and iron ores, usually argentiferous, are mined in Colorado and elsewhere, and are used as fluxes in western lead smelters; they are included under ores of the precious metals.

*Chromium ore.*—Chromic iron ore or chromite is usually reported in long tons. The output, mainly from California and used chiefly to supply pigments, in special tanning processes, for furnace linings, and in steel alloys, was 205 long tons in 1910 and 120 long tons in 1911.

*Tungsten ore.*—Tungsten ore is usually reported in short tons and that given in the table is in part estimated and includes output from reworking of several thousand tons of old tailings. The ordinary commercial basis for tungsten ores in the United States is a content of 60 per cent tungsten trioxide. The metal is chiefly used for making high-speed steels and for making the filament of the tungsten incandescent electric lamp, although the total requirement for this last-named purpose is relatively small.

*Vanadium ore.*—Production of vanadiferous ores has lately considerably increased and has probably more than supplied a growing demand in the steel trade for the metal. The output could not be reported separately for 1910 and is given combined with that of uranium ore (carnotite) in the table for 1911.

*Titanium ore.*—The domestic output of titanium ore has been mainly rutile from Virginia. No mine production was reported in 1911. The use is chiefly for making ferrotitanium for steels and titanium carbide for electrodes, and this demand is in part supplied by the use of titaniferous magnetite and ilmenite, both of which are more plentiful and cheaper than rutile.

*Aluminum ore.*—The figures for aluminum ore given in the table are for domestic output of bauxite. In long tons, as usually reported, the production was 148,932 long tons in 1910 and 155,618 long tons in 1911. The output is mainly from Arkansas, Georgia, Alabama, and Tennessee. A possible new source of aluminum is alunite, deposits of which have recently been recognized and developed in Utah and elsewhere, attention being called to them mainly as a new source for potash. The chief uses of bauxite are as raw material in production of metallic aluminum, and in the manufacture of aluminum salts, bauxite bricks and alundum (an abrasive).

*Gold ore.*—The figures given for gold ore include siliceous, pyritic, and other ores in which the predominant value is for gold. The domestic gold output is derived not only from gold ore but also from gravels of placer mines. Satisfactory figures for the quantity of

gravels washed are not available for 1911, but it is hoped they will be secured by the Survey for future reports. A portion of the gold output is also derived from copper, lead, and mixed base-metal ores.

*Silver ore.*—The production of silver ore given is mainly of silver-gold ores in which the value of silver exceeds that of the gold. Of the total production in 1911, Nevada (mainly Tonopah) is credited with 465,063 short tons, New Mexico with 91,375 tons, Utah with 67,948 tons, Colorado with 67,282 tons, Texas with 21,644 tons, and Arizona with 15,403 tons. The Colorado output is largely of iron-manganese-silver ores from Leadville used as flux in the lead furnaces. Pure silver ore is rare. About two-thirds of the silver production of the United States is derived as a by-product of lead and copper ores.

*Quicksilver ore.*—No quicksilver ore is imported. Of the domestic output, ore treated in 1910 included 115,306 short tons, averaging 0.515 per cent of metal, in California, and 8,256 tons, averaging 1.54 per cent, in Texas and Nevada combined. In 1911 the production was 130,926 short tons, averaging 0.54 per cent in California, and 7,599 tons, averaging 1.18 per cent in Nevada and Texas combined.

*Tin ore.*—The domestic production of tin ore was partly from placer operations, mainly in Alaska—and in this case the gravel dredged is estimated in short tons—and partly from deep mines, in Texas.

*Copper ore.*—The copper ores of the Western States are in part concentrated and in part smelted crude. Those from Michigan are always concentrated, and those from Tennessee are smelted crude. The total quantity of copper concentrates produced in 1910 was 2,063,824 short tons and in 1911 it was 2,202,590 tons. A small part of the domestic copper output is derived from gold, lead, zinc, and mixed ores.

*Lead ore.*—The lead ores of the Western and the Central States are generally concentrated. The production of lead concentrates from the Central States, mainly from southeastern Missouri, was 260,967 short tons in 1910 and 270,883 short tons in 1911. The output of lead concentrates in Idaho, the largest producer in the Western States, was 209,068 short tons, and the production in Utah was 107,006 short tons, in 1911.

*Zinc ore.*—A considerable part of the production of zinc ore is used in the manufacture of pigments. Except some western ores, which are shipped crude, the zinc ores are generally concentrated. The zinc ore and concentrates of the Eastern States are mainly from Franklin Furnace, N. J., but also from eastern Tennessee and southwestern Virginia. The output from the Central States is chiefly from Missouri, Wisconsin, and Kansas, in the order named, and that from the Western States is mainly from Colorado, Montana, New Mexico, Utah, Nevada, and California.

The following table shows the production of zinc concentrates in 1910 and 1911:

*Production of zinc concentrates in 1910 and 1911, in short tons.*[1]

| | 1910 | 1911 |
|---|---|---|
| Western States[1] | 171,653 | 149,000 |
| Central States | 403,893 | 381,579 |
| Eastern States | 334,391 | 257,133 |

[1] Leadville (Colo.), only for 1910.

# IRON ORE, PIG IRON, AND STEEL.

By Ernest F. Burchard.

## INTRODUCTION.

Among the most noteworthy features of the iron mining and manufacturing industries in the United States in 1911 was the decided decrease in production of iron ore, pig iron, and steel compared with the production in 1910. This decrease was due primarily to the fact that there was a large overproduction in 1910, and secondarily to a lessening in demand in 1911. Buying on the part of railroads and for new equipment of manufacturing plants was curtailed. Prices did not reach the lowest levels and thus afforded no incentive to stimulate buying. These conditions were foreshadowed in the last four months of 1910 and lasted well into the second half of 1911, but in the closing months of the year recovery was rapid and at the end of the year there was a decidedly more hopeful tone.

Other features of the year's progress were the initial shipments of iron ore from the Cuyuna range, in Minnesota, on which prospecting has been in progress for about nine years and development work has been done during the last two or three years. Active exploratory work has been carried on in the Marquette and Menominee ranges, and several new deposits have been blocked out. The Michigan State board of tax commissioners appraised the value of the iron mining properties of the State, using as a basis an estimate of the iron ore reserves of Michigan made by C. K. Leith, a summary of which is published elsewhere in Mineral Resources for 1911.

A strong movement for the conservation of iron ore by beneficiation (washing, concentrating, roasting, nodulizing, and briquetting) is under way in the Lake Superior region. The plants for dressing iron ore, including works recently built and in operation and those now under construction, are the following: [1]

Sand washeries for the Oliver Iron Mining Co. and the International Harvester Co., at Coleraine and Nashwauk, Mesabi range.

Drying plants for the Hollister and Brunt mines, of the Crystal Falls district, and at Mountain Iron, Mesabi range.

Crushers for hard ores, at Biwabik, Escanaba, and elsewhere.

Roasting works for the Magpie and Atikokan mines, at Magpie, Michipicoten range, and at Port Arthur, Ontario.

Pyrite washery for the Helen mine, Michipicoten range.

Magnetic concentrator and briquetting work for the Moose Mountain mines, at Sellwood, Ontario.

Nodulizing plant for the Kloman mine, at Republic, Marquette range.

Sizing and briquetting plant at the Northwestern Iron Co. mine, Mayville, Wis.

[1] Woodbridge, D. E., Lake Superior ore developments in 1911: Iron Age, Jan. 4, 1912, p. 67.

The curve showing pig-iron production by months (fig. 3) affords a graphic index of the trend of the pig-iron industry from the beginning to the end of the year and also a comparison of the conditions in 1911 with those during the preceding four years. The monthly course of pig-iron production in 1911 was rather broken, with two peaks, one in March, the other in October, but the total variation approximated only about 400,000 tons, and the mean course ran slightly less than 1,950,000 tons a month. The year closed with a rising production, the daily production for December, 1911, averaging about 66,000 tons, as compared with 57,000 tons in December, 1910. On December 31, 1911, there were 231 furnaces in blast out of a total of 466; on the same date in 1910 there were 206 furnaces in blast out of a total of 473. The iron-ore output declined from that of 1910 by 13,339,101 long tons. The total quantity of iron ore marketed in 1911 for the purpose of making pig iron—that is, not including stocks left at mines nor iron ore used for fluxing other metallic ores nor in the manufacture of paints—was 40,989,808 long tons, as compared with 53,616,670 tons, in 1910 and with 51,155,437 tons in 1909; the output of pig iron, including ferroalloys, in 1911 was 23,649,547 long tons, as compared with 27,303,567 tons in 1910 and with 25,795,471 tons in 1909.

The ore reported as having been used for fluxing other metallic ores during 1911 amounted to 102,639 long tons, valued at $296,745, as compared with 125,172 long tons in 1910, valued at $446,996. The quantity of iron ore sold by the miners for paint during 1911 was reported as 10,251 long tons, valued at $31,092. Prices of pig iron, which steadily declined during 1910, rose slightly during the first four months of 1911, but later sagged slowly until the end of the year and closed at 50 to 75 cents lower than at the end of 1910.

The decrease in the production of iron ore in 1911 from that of 1910 was 23.4 per cent, and the decrease in the production of pig iron and steel was 13.38 per cent and 9.28 per cent, respectively.

## IRON-ORE INDUSTRY OF THE UNITED STATES.

### OUTPUT OF IRON ORE BY GEOGRAPHIC DISTRICTS.

The iron ore marketed in the United States in 1911 amounted to 40,989,808 long tons, valued at $86,419,830 at the mines. The iron ore mined in 1911 was 43,550,633 long tons, valued at $91,891,836, as compared with 56,889,734 long tons, valued at $140,735,607, mined in 1910. This represents a decrease of 23.4 per cent in tonnage and of 34.7 per cent in value. The average price per ton for the whole country in 1911 was $2.11, as compared with $2.47 in 1910. By the term "ore marketed" is meant the quantity of ore sold or used by the producer for the manufacture of pig iron, and practically coincides with the term "shipments" used by trade papers. The reason for not using the term "shipments" in collecting the iron ore statistics is that ore producers, especially those in the South who consume a large part of their production in their own furnaces adjacent to the mines, may differentiate their ore consumption from their shipments to distant points.

Iron ore was mined in 27 States during 1911. Of these, four States—Idaho, Montana, Nevada, and Utah—produced ores for fluxing only; part of Colorado's production was for fluxing and part for pig iron; Michigan produced a very small quantity for flux, and a

small quantity was produced in Missouri for special fluxing use; the remaining States produced ores for blast-furnace use.

The States in which iron ore occurs may be conveniently grouped into six geographic districts, namely:

1. *Northeastern district.*—Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, and Ohio.

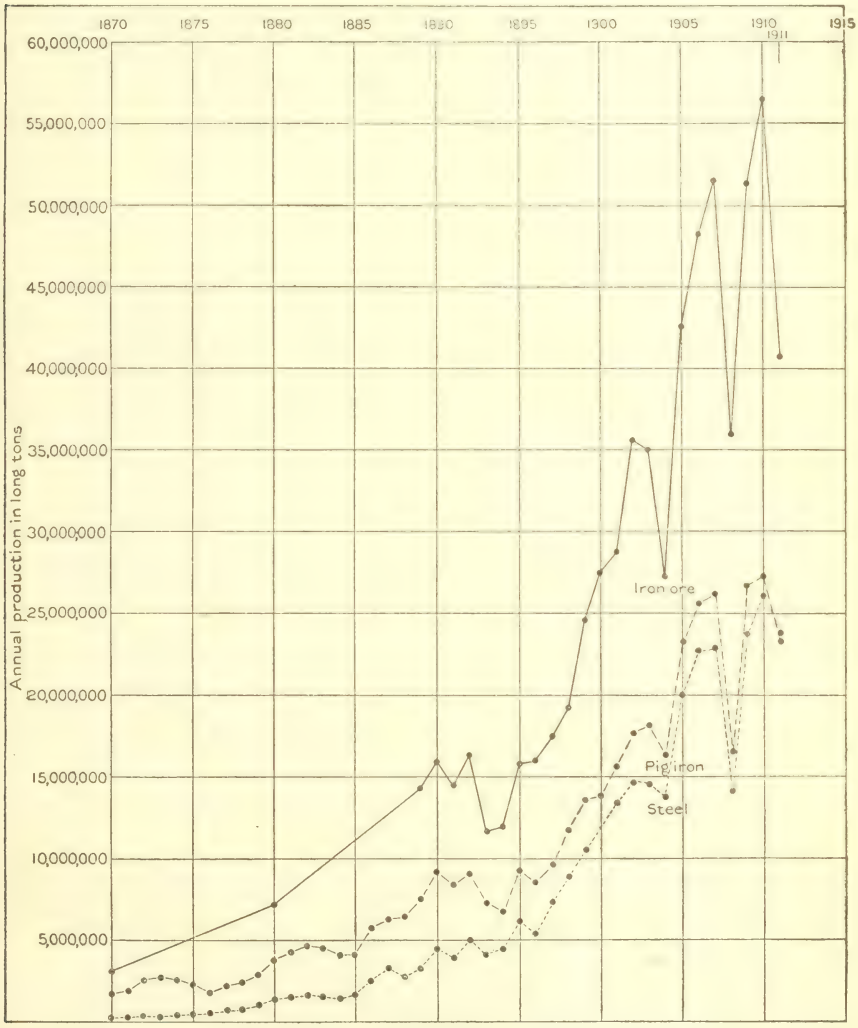



FIGURE 2.—Curve showing the production of iron ore, pig iron, and steel in the United States, 1870 to 1911.

2. *Southeastern district.*—Maryland, the Virginias, Kentucky, Tennessee, North Carolina, Georgia, and Alabama.

3. *Lake Superior district.*—Michigan, Wisconsin, and Minnesota.

4. *Mississippi Valley district.*—Iowa, Mississippi, Missouri, Arkansas, and Texas.

5. *Rocky Mountain district.*—Idaho, Montana, Wyoming, Colorado, New Mexico, Utah, and Nevada.

6. *Pacific slope district.*—Washington and California.

Each of these districts may be subdivided into mining districts and the ores classified with regard to variety and to distribution of deposits. These subdivisions are discussed in another section. The Lake Superior is by far the most important of these districts, and is followed in order by the southeastern district and the northeastern district; the Mississippi Valley and the western districts are of minor importance. The following table shows the relative output of iron ore in each of these geographic districts during 1909, 1910, and 1911:

*Production of iron ore in the United States, by geographic districts, in 1909, 1910, and 1911, in long tons.*

| District. | 1909 | | 1910 | | 1911 [a] | |
|---|---|---|---|---|---|---|
| | Quantity. | Percentage of total. | Quantity. | Percentage of total. | Quantity. | Percentage of total. |
| Northeastern | 2,280,741 | 4.46 | 2,605,318 | 4.58 | 1,966,348 | 4.80 |
| Southeastern | 6,197,717 | 12.11 | 6,894,464 | 12.12 | 5,407,821 | 13.19 |
| Lake Superior | 41,942,969 | 81.99 | 46,420,226 | 81.60 | 32,902,562 | 80.27 |
| Mississippi Valley | 96,428 | .19 | 107,876 | .19 | 73,388 | .18 |
| Rocky Mountain | 637,582 | 1.25 | 861,850 | 1.51 | 639,689 | 1.56 |
| Pacific slope | (b) | ..... | (b) | ..... | (b) | ..... |
| Total | 51,155,437 | 100.00 | 56,889,734 | 100.00 | 40,989,808 | 100.00 |

[a] Figures for 1911 represent marketed production.
[b] Pacific slope included in Rocky Mountain district.

## PRODUCTION OF IRON ORE BY STATES.

The following table gives a comparison of the iron-ore production, by States, for 1910 and 1911, showing increase and decrease and the percentage of increase and decrease in the several States, the figures for 1911 representing marketed production:

*Quantity and value of iron ore produced in the United States, 1910 and 1911, by States.*

| State. | 1910 | | 1911 | | Increase (+) or decrease (−) in 1911. | | Percentage of increase (+) or decrease (−) in 1911. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity, in long tons. | Value. | Quantity, in long tons. | Value. | Quantity, in long tons. | Value. | Quantity. | Value. |
| Alabama | 4,801,275 | $6,083,722 | 3,955,582 | $4,876,106 | − 845,693 | −$1,207,616 | − 17.61 | − 19.85 |
| Georgia | 313,878 | 482,659 | 207,279 | 315,704 | − 106,599 | − 166,955 | − 33.96 | − 34.59 |
| Kentucky and West Virginia | 64,347 | 86,085 | 71,979 | 92,575 | + 7,632 | + 6,490 | + 11.86 | + 7.54 |
| Maryland and North Carolina | 79,340 | 143,342 | 92,382 | 161,929 | + 13,042 | + 18,587 | + 16.44 | + 12.97 |
| Michigan | 13,303,906 | 41,393,585 | 8,944,393 | 23,808,935 | −4,359,513 | −17,584,650 | − 32.77 | − 42.48 |
| Minnesota | 31,966,769 | 78,462,560 | 23,398,406 | 48,447,760 | −8,568,363 | −30,014,800 | − 26.80 | − 38.25 |
| Missouri | 78,341 | 168,697 | 72,788 | 153,676 | − 5,553 | − 15,021 | − 7.09 | − 8.90 |
| New Jersey | 521,832 | 1,582,213 | 359,721 | 1,158,271 | − 162,111 | − 423,942 | − 31.07 | − 26.79 |
| New York | 1,287,209 | 3,848,683 | 1,057,984 | 2,959,009 | − 229,225 | − 889,674 | − 17.81 | − 23.12 |
| Ohio | 22,320 | 35,866 | 16,697 | 30,549 | − 5,623 | − 5,317 | − 25.19 | − 14.82 |
| Pennsylvania | 739,799 | 911,847 | 514,929 | 539,553 | − 224,870 | − 372,294 | − 30.40 | − 40.83 |
| Tennessee | 732,247 | 1,048,323 | 469,728 | 632,339 | − 262,519 | − 415,984 | − 35.85 | − 39.68 |
| Texas | 29,535 | 34,003 | ..... | ..... | − 29,535 | − 34,003 | −100.00 | −100.00 |
| Virginia | 903,377 | 1,845,144 | 610,871 | 1,146,188 | − 292,506 | − 698,856 | − 32.38 | − 37.88 |
| Wisconsin | 1,149,551 | 3,610,349 | 559,763 | 1,386,616 | − 589,788 | − 2,223,733 | − 51.30 | − 61.59 |
| Other States [a] | 896,008 | 998,529 | 657,306 | 710,620 | − 238,702 | − 287,909 | − 26.64 | − 28.83 |
| Total | 56,889,734 | 140,735,607 | 40,989,808 | 86,419,830 | −15,899,926 | −54,315,677 | − 27.95 | − 38.59 |

[a] 1910: California, Colorado, Connecticut, Massachusetts, New Mexico, Washington, and Wyoming; 1911: California, Colorado, Connecticut, Massachusetts, Mississippi, New Mexico, and Wyoming.

The columns showing percentage of increase or decrease bring out the interesting fact that with the exception of the groups Kentucky-West Virginia and Maryland-North Carolina every other State showed a decrease in both production and value, and that with the exception of New Jersey and Ohio in every producing State in which a decrease occurred the percentage of decrease in value was considerably greater than the percentage of decrease in quantity of ore marketed.

In the following table the States are arranged according to their rank in 1910 and 1911 with regard to both the quantity and the value of the iron ore marketed:

*Rank of iron-ore producing States in 1910 and 1911, with quantity and value of product and percentage of each.*

1910.

| Rank. | State. | Production. Quantity, in long tons. | Production. Percentage of total production. | Rank. | State. | Value. Amount. | Value. Percentage of total value. |
|---|---|---|---|---|---|---|---|
| 1 | Minnesota | 31,966,769 | 56.19 | 1 | Minnesota | $78,462,560 | 55.75 |
| 2 | Michigan | 13,303,906 | 23.39 | 2 | Michigan | 41,393,585 | 29.41 |
| 3 | Alabama | 4,801,275 | 8.44 | 3 | Alabama | 6,083,722 | 4.32 |
| 4 | New York | 1,287,209 | 2.26 | 4 | New York | 3,848,683 | 2.74 |
| 5 | Wisconsin | 1,149,551 | 2.02 | 5 | Wisconsin | 3,610,349 | 2.57 |
| 6 | Virginia | 903,377 | 1.59 | 6 | Virginia | 1,845,144 | 1.31 |
| 7 | California, Colorado, New Mexico, Washington, and Wyoming | 861,850 | 1.52 | 7 | New Jersey | 1,582,213 | 1.12 |
| | | | | 8 | Tennessee | 1,048,323 | .75 |
| | | | | 9 | Pennsylvania | 911,847 | .65 |
| 8 | Pennsylvania | 739,799 | 1.30 | 10 | California, Colorado, New Mexico, Washington, and Wyoming | 877,223 | .62 |
| 9 | Tennessee | 732,247 | 1.29 | | | | |
| 10 | New Jersey | 521,832 | .92 | | | | |
| 11 | Georgia | 313,878 | .55 | 11 | Georgia | 482,659 | .34 |
| 12 | Missouri | 78,341 | .14 | 12 | Missouri | 168,697 | .12 |
| 13 | North Carolina | 65,278 | .11 | 13 | Connecticut and Massachusetts | 121,306 | .09 |
| 14 | Kentucky and West Virginia | 64,347 | .11 | 14 | North Carolina | 114,237 | .08 |
| 15 | Connecticut and Massachusetts | 34,158 | .06 | 15 | Kentucky and West Virginia | 86,085 | .06 |
| 16 | Texas | 29,535 | .05 | 16 | Ohio | 35,866 | .03 |
| 17 | Ohio | 22,320 | .04 | 17 | Texas | 34,003 | .02 |
| 18 | Maryland | 14,062 | .02 | 18 | Maryland | 29,105 | .02 |
| | Total | 56,889,734 | 100.00 | | Total | 140,735,607 | 100.00 |

1911.

ORE MARKETED.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Minnesota | 23,398,406 | 57.08 | 1 | Minnesota | $48,447,760 | 56.06 |
| 2 | Michigan | 8,944,393 | 21.82 | 2 | Michigan | 23,808,935 | 27.55 |
| 3 | Alabama | 3,955,582 | 9.65 | 3 | Alabama | 4,876,106 | 5.64 |
| 4 | New York | 1,057,984 | 2.58 | 4 | New York | 2,959,009 | 3.42 |
| 5 | Virginia | 610,871 | 1.49 | 5 | Wisconsin | 1,386,616 | 1.60 |
| 6 | Wisconsin | 559,763 | 1.37 | 6 | New Jersey | 1,158,271 | 1.34 |
| 7 | Pennsylvania | 514,929 | 1.26 | 7 | Virginia | 1,146,188 | 1.33 |
| 8 | Tennessee | 469,728 | 1.15 | 8 | Tennessee | 632,339 | .73 |
| 9 | New Jersey | 359,721 | .88 | 9 | Pennsylvania | 539,553 | .62 |
| 10 | Georgia | 207,279 | .50 | 10 | Georgia | 315,704 | .37 |
| 11 | Maryland and North Carolina | 92,382 | .22 | 11 | Maryland and North Carolina | 161,929 | .19 |
| 12 | Missouri | 72,788 | .18 | 12 | Missouri | 153,676 | .18 |
| 13 | Kentucky and West Virginia | 71,979 | .18 | 13 | Kentucky and West Virginia | 92,575 | .11 |
| 14 | Ohio | 16,697 | .04 | 14 | Ohio | 30,549 | .04 |
| | Other States [a] | 657,306 | 1.60 | | Other States [a] | 710,620 | .82 |
| | Total | 40,989,808 | 100.00 | | Total | 86,419,830 | 100.00 |

[a] California, Colorado, Connecticut, Massachusetts, Mississippi, New Mexico, and Wyoming.

## IRON ORE MARKETED BY VARIETIES BY STATES AND MINING DISTRICTS.

Iron minerals are classified as sulphides, oxides, carbonates, silicates, etc., of which only the oxides and the carbonates are used in the iron and steel industry, except a very small quantity of by-product from sulphide ores used in acid manufacture. The ores of iron are generally classed under four heads:

1. *Hematite.*—Including all the anhydrous sesquioxides ($Fe_2O_3$—theoretical percentage of iron, 70). This is known locally as red hematite, specular ore, gray ore, fossil ore, oolitic ore, etc.

2. *Brown ore.*—Including hydrated sesquioxides, such as limonite, göthite, and turgite ($Fe_2O_3nH_2O$—theoretical percentage of iron, 59.8–66). This is known locally as brown iron ore, brown hematite, bog ore, limonite, etc.

3. *Magnetite.*—Including magnetic oxides ($Fe_3O_4$—theoretical percentage of iron, 72.4). Magnetite is known generally as magnetic iron ore.

4. *Iron carbonate.*—Including carbonates of various types ($FeCO_3$—theoretical percentage of iron, 48.2). Iron carbonate is known locally as spathic iron ore, kidney ore, black band ore, siderite, etc.

Hematite has always been predominant as an ore of iron, and at present constitutes about nine-tenths of the iron ore produced. Brown ore and magnetite are far below it in importance; each furnishes at present about one-twentieth of the total iron-ore production. The production of iron carbonate is insignificant in comparison with that of the other ores; it constitutes only about 0.04 per cent of the total.

In the following table are shown the quantities of each of the classes of iron ores marketed in the various States during 1910 and 1911:

*Production of iron ore in the United States in 1910 and 1911, by States and varieties, in long tons.*

1910.

| State. | Hematite. | Brown ore. | Magnetite. | Carbonate. | Total quantity. |
|---|---|---|---|---|---|
| Alabama | 3,678,139 | 1,123,136 | ..... | ..... | 4,801,275 |
| California, Colorado, New Mexico, Washington, and Wyoming | 656,629 | 15,975 | 189,246 | ..... | 861,850 |
| Connecticut and Massachusetts | ..... | 34,158 | ..... | ..... | 34,158 |
| Georgia | 60,324 | 253,554 | ..... | ..... | 313,878 |
| Kentucky and West Virginia | 47,493 | 16,854 | ..... | ..... | 64,347 |
| Maryland | ..... | 14,062 | ..... | ..... | 14,062 |
| Michigan | 13,303,906 | ..... | ..... | ..... | 13,303,906 |
| Minnesota | 31,966,769 | ..... | ..... | ..... | 31,966,769 |
| Missouri | 55,832 | 22,509 | ..... | ..... | 78,341 |
| New Jersey | ..... | (a) | a 521,832 | ..... | 521,832 |
| New York | 64,738 | (a) | a 1,222,471 | ..... | 1,287,209 |
| North Carolina | ..... | ..... | 65,278 | ..... | 65,278 |
| Ohio | ..... | ..... | ..... | 22,320 | 22,320 |
| Pennsylvania | 846 | 106,544 | 632,409 | ..... | 739,799 |
| Tennessee | 301,838 | 430,409 | ..... | ..... | 732,247 |
| Texas | ..... | 29,535 | ..... | ..... | 29,535 |
| Virginia | 81,647 | 821,131 | 599 | ..... | 903,377 |
| Wisconsin | 1,148,846 | 705 | ..... | ..... | 1,149,551 |
| Total | 51,367,007 | 2,868,572 | 2,631,835 | 22,320 | 56,889,734 |

a Brown ore is included in magnetite.

*Production of iron ore in the United States in 1910 and 1911, by States and varieties, in long tons*—Continued.

1911.[a]

| State. | Hematite. | Brown ore. | Magnetite. | Carbonate. | Total quantity. |
|---|---|---|---|---|---|
| Alabama | 3,119,696 | 835,886 | ..... | ..... | 3,955,582 |
| Georgia | 18,545 | 188,734 | ..... | ..... | 207,279 |
| Kentucky and West Virginia | 57,770 | 14,209 | ..... | ..... | 71,979 |
| Maryland and North Carolina | ..... | 7,600 | 84,782 | ..... | 92,382 |
| Michigan | 8,944,393 | ..... | ..... | ..... | 8,944,393 |
| Minnesota | 23,398,406 | ..... | ..... | ..... | 23,398,406 |
| Missouri | 60,479 | 12,309 | ..... | ..... | 72,788 |
| New Jersey | ..... | [b] | [a] 359,721 | ..... | 359,721 |
| New York | 29,790 | ..... | 1,028,194 | ..... | 1,057,984 |
| Ohio | ..... | ..... | ..... | 16,697 | 16,697 |
| Pennsylvania | 9,792 | 50,394 | 454,743 | ..... | 514,929 |
| Tennessee | 251,083 | 218,645 | ..... | ..... | 469,728 |
| Virginia | 68,139 | 541,870 | 862 | ..... | 610,871 |
| Wisconsin | 559,763 | ..... | ..... | ..... | 559,763 |
| Other States [c] | 479,922 | 31,692 | 145,692 | ..... | 657,306 |
| Total | 36,997,778 | 1,901,339 | 2,073,994 | 16,697 | 40,989,808 |

[a] Quantities marketed.
[b] Brown ore is included in magnetite.
[c] California, Colorado, Connecticut, Massachusetts, Mississippi, New Mexico, and Wyoming.

From this table it will be seen that the great bulk of the hematite comes from the Lake Superior district (Michigan, Minnesota, and Wisconsin) and Alabama, the bulk of the brown ore from the Appalachian States, and the magnetite from New York, New Jersey, and Pennsylvania. All the iron carbonate is obtained from Ohio. On a later page is given the production of the principal ranges in the Lake Superior district. In the report for 1909 the production was given for the first time of two important southern mining centers, the Birmingham and the Chattanooga districts. In the Birmingham district are included, besides the mines in the immediate vicinity of Birmingham, those in eastern Alabama that ship ores to the furnaces at Birmingham. In the Chattanooga district are included those mines that ship ores to Chattanooga, Dayton, and Rockwood, Tenn., to Rome, Ga., and to Anniston, Ironaton, Rockrun, Gadsden, Alabama City, and Attalla, Ala. The brown ore mines near Russellville, Ala., and in west-central Tennessee are not included in either district.

The following table presents the production of iron ore in the principal mining districts and by varieties during 1910 and 1911:

*Production of iron ore in the United States, by mining districts and varieties, in 1910 and 1911, in long tons.*

1910.

| District. | Hematite. | Brown ore. | Magnetite. | Carbonate. | Total. |
|---|---|---|---|---|---|
| Lake Superior | 46,328,743 | ..... | ..... | ..... | 46,328,743 |
| Birmingham | 3,300,433 | 501,682 | ..... | ..... | 3,802,115 |
| Chattanooga | 712,817 | 500,742 | ..... | ..... | 1,213,559 |
| Adirondack | [a] | ..... | [a] 1,146,080 | ..... | 1,146,080 |
| Northern New Jersey and southeastern New York | ..... | [b] | [b] 598,601 | ..... | 598,601 |
| Other | 1,018,636 | 1,866,148 | 893,532 | 22,320 | 3,800,636 |
| Total | 51,360,629 | 2,868,572 | 2,638,213 | 22,320 | 56,889,734 |

[a] Hematite is included in magnetite.
[b] Brown ore is included in magnetite.

*Production of iron ore in the United States, by mining districts and varieties, in 1910 and 1911, in long tons*—Continued.

1911.

| District. | Hematite. | Brown ore. | Magnetite. | Carbonate. | Total. |
|---|---|---|---|---|---|
| Lake Superior | 32,783,163 | ..... | ..... | ..... | 32,783,163 |
| Birmingham | 2,853,993 | 412,531 | ..... | ..... | 3,266,524 |
| Chattanooga | 521,006 | 396,618 | ..... | ..... | 917,624 |
| Adirondack | ..... | ..... | 902,930 | ..... | 902,930 |
| Northern New Jersey and southeastern New York | ..... | (a) | 484,985 | ..... | 484,985 |
| Other | 839,616 | 1,092,190 | 686,079 | 16,697 | 2,634,582 |
| Total | 36,997,778 | 1,901,339 | 2,073,994 | 16,697 | 40,989,808 |

a Brown ore is included in magnetite.

## TOTAL PRODUCTION OF IRON ORE.

In the following table is shown the production of various types of iron ore in the United States as far as has been recorded. The statistics from 1889 to the present were collected by the United States Geological Survey; those for 1860, 1870, and 1880 were collected for the census reports of those years; those for 1875 and 1881 were estimated by I. L. Bell;[1] and those from 1882 to 1888, inclusive, were estimated by James M. Swank[2] from the pig-iron production. The figures for 1909 represent ore marketed. No figures can be obtained for the production of various classes of iron ores prior to 1889, except for the census year 1880.

*Production of iron ore in the United States, 1860–1911, in long tons.*

| Year. | Hematite. | Brown ore. | Magnetite. | Carbonate. | Total. |
|---|---|---|---|---|---|
| 1860 | ..... | ..... | ..... | ..... | 2,873,460 |
| 1870 | ..... | ..... | ..... | ..... | a 3,831,891 |
| 1875 | ..... | ..... | ..... | ..... | 4,017,857 |
| 1880 | 2,243,993 | 1,918,622 | 2,134,276 | 823,471 | 7,120,362 |
| 1881 | ..... | ..... | ..... | ..... | 7,119,643 |
| 1882 | ..... | ..... | ..... | ..... | b 8,700,000 |
| 1883 | ..... | ..... | ..... | ..... | b 8,800,000 |
| 1884 | ..... | ..... | ..... | ..... | b 7,718,129 |
| 1885 | ..... | ..... | ..... | ..... | b 7,600,000 |
| 1886 | ..... | ..... | ..... | ..... | b 10,000,000 |
| 1887 | ..... | ..... | ..... | ..... | b 11,300,000 |
| 1888 | ..... | ..... | ..... | ..... | b 12,062,530 |
| 1889 | 9,056,288 | 2,523,087 | 2,506,415 | 432,251 | 14,518,041 |
| 1890 | 10,527,650 | 2,559,938 | 2,570,838 | 377,617 | 16,036,043 |
| 1891 | 9,327,398 | 2,757,564 | 2,317,108 | 189,108 | 14,591,178 |
| 1892 | 11,646,619 | 2,485,101 | 1,971,965 | 192,981 | 16,296,666 |
| 1893 | 8,272,637 | 1,849,272 | 1,330,886 | 134,834 | 11,587,629 |
| 1894 | 9,347,434 | 1,472,748 | 972,219 | 87,278 | 11,879,679 |
| 1895 | 12,513,995 | 2,102,358 | 1,268,222 | 73,039 | 15,957,614 |
| 1896 | 12,576,288 | 2,126,212 | 1,211,526 | 91,423 | 16,005,449 |
| 1897 | 14,413,318 | 1,961,954 | 1,059,479 | 83,295 | 17,518,046 |
| 1898 | 16,150,684 | 1,989,681 | 1,237,978 | 55,373 | 19,433,716 |
| 1899 | 20,004,399 | 2,869,785 | 1,727,430 | 81,559 | 24,683,173 |
| 1900 | 22,708,274 | 3,231,089 | 1,537,551 | 76,247 | 27,553,161 |
| 1901 | 24,006,025 | 3,016,715 | 1,813,076 | 51,663 | 28,887,479 |
| 1902 | 30,332,149 | 3,305,484 | 1,688,860 | 27,642 | 35,554,135 |
| 1903 | 30,328,654 | 3,080,399 | 1,575,422 | 34,833 | 35,019,308 |
| 1904 | 23,839,477 | 2,146,795 | 1,638,846 | 19,212 | 27,644,330 |
| 1905 | 37,567,055 | 2,546,662 | 2,390,417 | 21,999 | 42,526,133 |
| 1906 | 42,481,375 | 2,781,063 | 2,469,294 | 17,996 | 47,749,728 |
| 1907 | 46,060,486 | 2,957,477 | 2,679,067 | 23,589 | 51,720,619 |
| 1908 | 31,788,564 | c 2,561,825 | c 1,547,797 | 26,585 | d 35,924,771 |
| 1909 | 46,208,640 | c 2,700,431 | c 2,229,839 | 16,527 | d 51,155,437 |
| 1910 | 51,367,007 | c 2,868,572 | c 2,631,835 | 22,320 | d 56,889,734 |
| 1911 | 36,997,778 | c 1,901,339 | c 2,073,994 | 16,697 | d 43,550,633 |

a Includes ore produced by owners of blast furnaces, estimated by census at 800,000 tons.
b Figures given are for consumption of domestic ores. Total production for 1882, 1883, and 1884 is estimated as 9,000,000, 8,100,000, and 8,200,000 tons, respectively. See Mineral Resources U. S. for 1883 and 1884.
c Some brown ore included in magnetite.
d Ore used for fluxing purposes excluded from production figures after 1907. In 1910 and 1911 ore sold for paint excluded from iron-ore production and included in metallic paint.

[1] Bell, T. L., Principles of the manufacture of iron and steel, 1884, p. 451.
[2] Mineral Resources U. S., 1882 to 1888.

In the following table the production of iron ore in the United States is shown from 1810 to 1869, and by decades from 1870 to 1909. The figures for the years previous to 1889 were calculated from the pig-iron production and include imported ore as well as domestic ore used. Ore used for flux has been deducted from the production in 1908 and 1909.

*Production of iron ore in the United States from 1810 to 1909, by decades, and rate of increase.*

| Decade. | Quantity in long tons. | Percentage of increase. | Decade. | Quantity in long tons. | Percentage of increase. |
|---|---|---|---|---|---|
| 1810–1869 | 49,656,000 | | 1890–1899 | 103,989,193 | 80.1 |
| 1870–1879 | 44,570,627 | | 1900–1909 a | 383,133,101 | 134.0 |
| 1880–1889 | 91,043,854 | 104.3 | | | |

a Iron ore used for flux excluded from production for 1908 and 1909.

## PRINCIPAL IRON-ORE MINES.

During 1911, of the 374 iron-ore mines that reported sales or consumption of ore, 159 mines produced over 50,000 long tons of iron ore each, as compared with 191 mines in 1910. The largest quantity produced by any single mine in 1911 was 1,553,510 long tons, from the Hill mine at Marble, on the Mesabi range, Minnesota. Six mines in Minnesota, besides one group in Alabama, produced more than 1,000,000 tons each, and the second largest quantity was 1,343,064 long tons, produced by the Canisteo mine at Coleraine, also on the Mesabi range. Permission has been granted to the Survey by the owners and operators of 123 of these mines to publish their production, and this information is given in the following table:

*Iron-ore mines of the United States that produced more than 50,000 long tons each in 1911.*

| Rank. | Name of mine. | State. | Nearest town. | Variety of ore. | Quantity. |
|---|---|---|---|---|---|
| 1 | Hill | Minnesota | Marble | Hematite | 1,553,510 |
| 2 | Canisteo | do | Coleraine | do | 1,343,064 |
| 3 | Leonard | do | Chisholm | do | 1,293,170 |
| 4 | Country Alpena | do | Virginia | do | 1,057,539 |
| 5 | Mahoning | do | Hibbing | do | 1,011,945 |
| 6 | Dale | do | do | do | 1,004,848 |
| 7 | Genoa | do | Colbert | do | 924,454 |
| 8 | Holman | do | Taconite | do | 780,665 |
| 9 | Uno | do | Hibbing | do | 746,995 |
| 10 | Chisholm | do | Chisholm | do | 724,798 |
| 11 | Shenango | do | do | do | 709,159 |
| 12 | Norrie group | Michigan | Ironwood | do | 662,054 |
| 13 | Virginia group | Minnesota | Virginia | do | 649,675 |
| 14 | Spruce | do | Eveleth | do | 638,773 |
| 15 | Newport | Michigan | Ironwood | do | 555,853 |
| 16 | Clark | Minnesota | Chisholm | do | 503,597 |
| 17 | Woodward | Alabama | Woodward | do | 502,471 |
| 18 | Stevenson | Minnesota | Hibbing | do | 500,323 |
| 19 | Hull-Rust | do | do | do | 496,977 |
| 20 | Witherbee, Sherman & Co., Inc. (Mineville). | New York | Mineville | Magnetite | 463,827 |
| 21 | Kinney | Minnesota | Kinney | Hematite | 456,107 |
| 22 | Cornwall | Pennsylvania | Miners Village | Magnetite | 454,248 |
| 23 | Zenith | Minnesota | Ely | Hematite | 449,727 |
| 24 | Fayal | do | Eveleth | do | 443,804 |
| 25 | Penn | Michigan | Vulcan | do | 431,200 |
| 26 | Adams | Minnesota | Eveleth | do | 411,749 |
| 27 | Pioneer | do | Ely | do | 401,430 |
| 28 | Chapin | Michigan | Iron Mountain | do | 357,598 |
| 29 | Mary Charlotte, Nos. 1 and 2 | do | Negaunee | do | 343,454 |

*Iron-ore mines of the United States that produced more than 50,000 long tons each in 1911*—Continued.

| Rank. | Name of mine. | State. | Nearest town. | Variety of ore. | Quantity. |
|---|---|---|---|---|---|
| 30 | Tobin | Michigan | Crystal Falls | Hematite | 333,798 |
| 31 | Mississippi | Minnesota | Keewatin | do | 329,032 |
| 32 | Bristol | Michigan | Crystal Falls | do | 322,647 |
| 33 | Queen group | do | Negaunee | do | 297,675 |
| 34 | Commodore | Minnesota | Virginia | do | 294,787 |
| 35 | Harold | do | Hibbing | do | 281,943 |
| 36 | Miller | do | Aurora | do | 247,557 |
| 37 | Hawkins | do | Nashwauk | do | 240,077 |
| 38 | Dunn | Michigan | Crystal Falls | do | 232,092 |
| 39 | Laura | Minnesota | Hibbing | do | 210,397 |
| 40 | Biwabik | do | Biwabik | do | 209,000 |
| 41 | Whiteside | do | Buhl | do | 207,707 |
| 42 | Aragon | Michigan | Norway | do | 201,269 |
| 43 | Riverton group | do | Iron River | do | 200,142 |
| 44 | Aurora | do | Ironwood | do | 181,859 |
| 45 | Bessemer, No. 3 shaft | Minnesota | Virginia | do | 179,055 |
| 46 | Brown Mining Co. | Tennessee | Cardiff | do | 178,819 |
| 47 | Raimund, No. 1 | Alabama | Bessemer | do | 178,793 |
| 48 | Port Henry, No. 21 | New York | Mineville | Magnetite | 176,251 |
| 49 | Lake Superior | Michigan | Ishpeming | Hematite | 174,874 |
| 50 | American-Boston | do | Diorite | do | 174,723 |
| 51 | Lake Angeline | do | Ishpeming | do | 167,258 |
| 52 | Caspian | do | Palatka | do | 165,660 |
| 53 | Sliver | Minnesota | Virginia | do | 165,510 |
| 54 | Elba | do | McKinley | do | 165,055 |
| 55 | Songo | Alabama | Birmingham | do | 161,912 |
| 56 | Yale | Michigan | Bessemer | do | 155,487 |
| 57 | Agnew | Minnesota | Hibbing | do | 153,373 |
| 58 | Montreal | Wisconsin | Hurley | do | 153,122 |
| 59 | Kennedy | Minnesota | Cuyuna | do | 147,431 |
| 60 | Tilden | Michigan | Bessemer | do | 138,387 |
| 61 | Brunt | Minnesota | Mountain Iron | do | 135,189 |
| 62 | Baltic | Michigan | Palatka | do | 134,118 |
| 63 | Albany | Minnesota | Hibbing | do | 132,573 |
| 64 | Raimund, No. 2 | Alabama | Bessemer | do | 131,314 |
| 65 | Pettit | Minnesota | Gilbert | do | 129,776 |
| 66 | Mace | do | Hibbing | do | 125,013 |
| 67 | Mohawk | do | Aurora | do | 121,822 |
| 68 | Schley | do | Gilbert | do | 120,365 |
| 69 | Republic | Michigan | Republic | do | 120,089 |
| 70 | Bangor | Minnesota | Biwabik | do | 119,508 |
| 71 | Cary | Wisconsin | Hurley | do | 119,169 |
| 72 | Hiawatha | Michigan | Iron River | do | 116,736 |
| 73 | Glen | Minnesota | Chisholm | do | 113,512 |
| 74 | Monica | do | Biwabik | do | 112,952 |
| 75 | Clinton | Alabama | Steinman | do | 111,374 |
| 76 | Zimmerman | Michigan | Stambaugh | do | 110,084 |
| 77 | Hemlock | do | Amasa | do | 105,320 |
| 78 | Richard | New Jersey | Wharton | Magnetite | 104,560 |
| 79 | Mayville | Wisconsin | Mayville | Hematite | 101,679 |
| 80 | Leonard-Burt | Minnesota | Chisholm | do | 100,723 |
| 81 | Utica | do | Hibbing | do | 100,123 |
| 82 | Crudup | Alabama | Gadsden | do | 99,486 |
| 83 | Eureka | Michigan | Ramsay | do | 98,609 |
| 84 | Virginia | Minnesota | Eveleth | do | 97,667 |
| 85 | Florence | Wisconsin | Florence | do | 96,560 |
| 86 | Myers | Minnesota | Chisholm | do | 93,203 |
| 87 | Savoy | do | Ely | do | 87,964 |
| 88 | Sellers | do | Hibbing | do | 87,324 |
| 89 | Cranberry | North Carolina | Cranberry | Magnetite | 84,782 |
| 90 | Raimund, No. 3 | Alabama | Bessemer | Hematite | 84,775 |
| 91 | Great Western | Michigan | Crystal Falls | do | 84,338 |
| 92 | Woodstock | Alabama | Woodstock | Brown ore | 83,362 |
| 93 | Houston | do | Rickey | do | 82,857 |
| 94 | Leonard-Glen | Minnesota | Chisholm | Hematite | 82,719 |
| 95 | Cyprus | do | Hibbing | do | 81,318 |
| 96 | Pearson | do | Nashwauk | do | 75,138 |
| 97 | Breitung Hematite, No. 2 | Michigan | Negaunee | do | 74,933 |
| 98 | Clifford and Traders | do | Iron Mountain | do | 74,138 |
| 99 | Adriatic | Minnesota | Mesabi | do | 73,280 |
| 100 | Minerca | do | Virginia | do | 67,942 |
| 101 | Cambria | Michigan | Negaunee | do | 67,869 |
| 102 | Hudson | Minnesota | Aurora | do | 67,278 |
| 103 | Franklin | do | Virginia | do | 66,350 |
| 104 | Soudan | do | Soudan | do | 65,350 |
| 105 | Brotherton | Michigan | Wakefield | do | 65,015 |
| 106 | Breitung Hematite, No. 1 | do | Negaunee | do | 64,643 |
| 107 | Corsica | Minnesota | McKinley | do | 63,940 |
| 108 | Onondaga | do | Virginia | do | 63,798 |
| 109 | Ironton | Michigan | Bessemer | do | 63,402 |
| 110 | Barron | do | Humboldt | do | 60,731 |

*Iron-ore mines of the United States that produced more than 50,000 long tons each in 1911*—Continued.

| Rank. | Name of mine. | State. | Nearest town. | Variety of ore. | Quantity. |
|---|---|---|---|---|---|
| 111 | Mannie | Tennessee | Allens Creek | Brown ore | 59,285 |
| 112 | Chatham | Michigan | Iron River | Hematite | 58,056 |
| 113 | Rose Run | Kentucky | Olympia | do | 57,770 |
| 114 | Euclid | Minnesota | Chisholm | do | 57,598 |
| 115 | Gibson | Michigan | Amasa | do | 57,099 |
| 116 | Madeira | Minnesota | Hibbing | do | 57,098 |
| 117 | Burt | do | do | do | 56,576 |
| 118 | Sunday Lake | Michigan | Wakefield | do | 56,096 |
| 119 | Mansfield | do | Crystal Falls | do | 54,646 |
| 120 | Winifred | Minnesota | Hibbing | do | 52,414 |
| 121 | Volunteer | Michigan | Negaunee | do | 51,864 |
| 122 | Armenia | do | Crystal Falls | do | 51,862 |
| 123 | Chandler | Minnesota | Ely | do | 50,206 |
| | Total (123 mines) | | | | 31,788,293 |
| | Unspecified (36 mines) [a] | | | | 6,141,435 |
| | Grand total | | | | 37,929,728 |

[a] Includes the product of 36 mines producing over 50,000 long tons each, operated by 19 companies, which do not permit the publication of individual statistics.

## STOCKS OF IRON ORE AT MINES.

Considerable stock was left at the mines at the end of 1911 which is not included in the marketed totals. On December 31, 1911, this stock amounted to 11,969,060 tons, as compared with 9,408,235 tons on December 31, 1910. Besides this stock at the mines, stocks are left at receiving ports and furnaces, but these are included in the total sales of ore.

The following table shows the tonnage of stock (exclusive of 30,050 long tons in 1910 and 5,425 tons in 1911 at mines which produce ore for flux only) left at the mines on December 31, 1910 and 1911, in the various States:

*Stock of iron ore on hand at the mines Dec. 31, 1910 and 1911, by States, in long tons.*

| State. | 1910 | 1911 | State. | 1910 | 1911 |
|---|---|---|---|---|---|
| Alabama | 716,340 | 588,549 | Pennsylvania | 11,839 | 33,116 |
| Georgia | 4,090 | 700 | Tennessee | 14,848 | 8,955 |
| Maryland | 1,020 | 4,000 | Texas | 10,600 | 24,000 |
| Massachusetts | 4,281 | 4,200 | Virginia | 11,348 | 14,500 |
| Michigan | 4,698,565 | 6,069,025 | West Virginia | | 15,000 |
| Minnesota | 3,486,277 | 4,572,653 | Wisconsin | 286,266 | 398,817 |
| Mississippi | | 50 | | | |
| Missouri | 8,625 | 1,140 | Total | 9,408,235 | 11,969,060 |
| New Jersey | 17,567 | 115,581 | Percentage of increase in 1911 | | 27.22 |
| New York | 119,139 | 102,334 | | | |
| Ohio | 17,430 | 16,440 | | | |

## PRICE OF IRON ORE PER TON.

In the following table the price per ton of the different classes of iron ore in 1910 and 1911 is given for each of the producing States or groups of States. The total average prices per long ton (considering the whole United States) in 1911 were: Hematite, $2.12; brown ore, $1.65; magnetite, $2.29; carbonate, $1.83, as compared with prices, respectively, of $2.52, $1.76, $2.36, and $1.61 in 1910. These figures represent the value at the mines and are taken directly

from statements of the producers. They should be accepted as only approximately correct. The element of inaccuracy arises from the fact that by far the greater bulk of the iron ore produced in the United States is mined by pig iron producers for their own furnaces, and the value placed on such ore is therefore largely a matter of accounting. Some of the reports made to the Survey evidently include merely actual mining costs; others contain an allowance for sinking fund; and in still others the figures given are merely convenient prices to use in charging costs against the blast furnaces.

It is to be noted, however, that the errors are almost entirely in one direction—that of undervaluing the ore rather than of overvaluing it. If all the iron ore were to be bought by blast furnaces in open market from an entirely distinct set of iron-ore producers, the average prices paid would probably exceed those now reported. It is of interest to compare the prices given below with those of the Lake Superior ores at the lower Lake ports given in a subsequent table. If the freight rates by rail from the mines to Duluth, Superior, Marquette, and Escanaba plus the freight rates by water are deducted from prices at lower Lake ports the margin of profit appears small.

*Average price per long ton of iron ore in the United States in 1910 and 1911, by States and varieties.*

| State. | Hematite. | | Brown ore. | | Magnetite. | | Carbonate. | |
|---|---|---|---|---|---|---|---|---|
| | 1910 | 1911 | 1910 | 1911 | 1910 | 1911 | 1910 | 1911 |
| Alabama | $1.19 | $1.17 | $1.53 | $1.47 | ..... | ..... | ..... | ..... |
| Georgia | 1.54 | 1.38 | 1.53 | 1.54 | ..... | ..... | ..... | ..... |
| Kentucky and West Virginia | 1.25 | 1.25 | 1.59 | 1.43 | ..... | ..... | ..... | ..... |
| Maryland and North Carolina | ..... | ..... | 2.07 | 1.78 | $1.75 | $1.75 | ..... | ..... |
| Michigan | 3.11 | 2.66 | ..... | ..... | ..... | ..... | ..... | ..... |
| Minnesota | 2.45 | 2.07 | ..... | ..... | ..... | ..... | ..... | ..... |
| Missouri | 2.23 | 2.17 | 1.96 | 1.83 | ..... | ..... | ..... | ..... |
| New Jersey | ..... | ..... | 3.87 | 3.70 | 3.03 | 3.22 | ..... | ..... |
| New York | 2.21 | 2.05 | 3.00 | ..... | 3.03 | 2.82 | ..... | ..... |
| Ohio | ..... | ..... | ..... | ..... | ..... | ..... | $1.61 | $1.83 |
| Pennsylvania | 2.34 | 1.87 | 2.60 | 2.37 | 1.00 | .88 | ..... | ..... |
| Tennessee | 1.25 | 1.26 | 1.56 | 1.45 | ..... | ..... | ..... | ..... |
| Texas | ..... | ..... | 1.15 | ..... | ..... | ..... | ..... | ..... |
| Virginia | 1.74 | 1.58 | 2.07 | 1.91 | 1.50 | 1.50 | ..... | ..... |
| Wisconsin | 3.14 | 2.48 | 2.50 | ..... | ..... | ..... | ..... | ..... |
| Other States[a] | 1.00 | 1.00 | 3.04 | 2.65 | 1.00 | 1.01 | ..... | ..... |
| Total average | 2.52 | 2.12 | 1.76 | 1.65 | 2.36 | 2.29 | 1.61 | 1.83 |

[a] 1910: California, Colorado, Connecticut, Massachusetts, New Mexico, Washington, and Wyoming; 1911: California, Colorado, Connecticut, Massachusetts, Mississippi, New Mexico, and Wyoming.

## APPARENT ANNUAL IRON-ORE CONSUMPTION.

The following table includes data on certain factors from which an approximate estimate of the annual consumption of iron ore in the United States is deduced. The result is, of course, merely an approximation, for no data are available on certain other factors which should enter into the final result. The elements considered in the table and estimates for all years except 1909 and 1911 are (1) domestic iron-ore production; (2) stocks of ore at mines for current year and past year; (3) stocks of ore at lower Lake ports for current year and past year; (4) zinc residuum production; (5) imports of ore; (6)

exports of ore. In 1909 and 1911 the sales, zinc residuum, and the imports constitute the available supply, which, less the exports gives the apparent consumption.

*Apparent consumption of iron ore in the United States, 1889–1911, in long tons.*

| Year. | Domestic iron ore produced.[a] | Stocks of ore at mines. | Stocks of ore at lower Lake ports Dec. 1. | Zinc residuum. | Imports. | Exports. | Apparent consumption. |
|---|---|---|---|---|---|---|---|
| 1889 | 14,518,041 | 2,256,973 | 2,607,106 | 43,648 | 853,573 | ..... | 14,366,562 |
| 1890 | 16,036,043 | 2,000,000 | 3,893,487 | 48,560 | 1,246,830 | ..... | 16,302,025 |
| 1891 | 14,591,178 | 2,450,279 | 3,508,489 | 38,228 | 912,864 | ..... | 15,476,989 |
| 1892 | 16,296,666 | 2,911,740 | 4,149,451 | 31,859 | 806,585 | ..... | 16,032,687 |
| 1893 | 11,587,629 | 3,526,161 | 4,070,710 | 37,512 | 526,951 | ..... | 11,616,412 |
| 1894 | 11,879,679 | 3,236,198 | 4,834,247 | 26,981 | 167,307 | ..... | 11,600,393 |
| 1895 | 15,957,614 | 2,976,494 | 4,415,712 | 43,249 | 524,153 | ..... | 17,203,255 |
| 1896 | 16,005,449 | 3,405,302 | 4,954,984 | 44,953 | 682,806 | ..... | 15,765,128 |
| 1897 | 17,518,046 | 3,098,287 | 5,923,755 | 33,924 | 489,970 | ..... | 17,380,184 |
| 1898 | 19,433,716 | 2,846,457 | 5,136,407 | 48,502 | 187,208 | ..... | 20,708,604 |
| 1899 | 24,683,173 | 2,320,278 | 5,530,283 | 65,010 | 674,082 | 40,665 | 25,513,903 |
| 1900 | 27,553,161 | 3,709,950 | 5,904,670 | 87,110 | 897,831 | 51,460 | 26,722,583 |
| 1901 | 28,887,479 | 4,239,823 | 5,859,663 | 52,311 | 966,950 | 64,703 | 29,357,171 |
| 1902 | 35,554,135 | 3,834,717 | 7,074,254 | 65,246 | 1,165,470 | 88,445 | 35,886,921 |
| 1903 | 35,019,308 | 6,297,888 | 6,371,085 | 73,264 | 980,440 | 80,611 | 34,232,399 |
| 1904 | 27,644,330 | 4,666,931 | 5,763,399 | 68,189 | 487,613 | 213,865 | 30,224,910 |
| 1905 | 42,526,133 | 3,812,281 | 6,438,967 | 90,289 | 845,651 | 208,017 | 43,433,138 |
| 1906 | 47,749,728 | 3,281,789 | 6,252,455 | 93,461 | 1,060,390 | 265,240 | 49,355,343 |
| 1907 | 51,720,619 | 3,033,110 | 7,385,728 | 93,413 | 1,229,168 | 278,608 | 51,879,998 |
| 1908 | 35,924,771 | 6,065,397 | 8,441,533 | 110,225 | 776,898 | 309,099 | 32,414,703 |
| 1909 | 51,155,437 | 6,135,171 | 8,965,789 | 141,264 | 1,694,957 | 455,934 | 52,535,724 |
| 1910 | 56,889,734 | 9,408,235 | 9,426,881 | 137,173 | 2,591,031 | 748,875 | 56,057,091 |
| 1911 | 40,989,808 | ..... | ..... | 109,296 | 1,811,732 | 768,386 | 42,142,450 |

[a] Prior to 1908 iron ore used for fluxing included in production. Such ore excluded 1908–1911. Iron ore sold for paint excluded from 1910 and 1911 production and included in metallic paint. In 1909 and 1911 figures represent sales.

## COMPARATIVE PRODUCTION OF IRON ORE AND PIG IRON.

Detailed data on the pig-iron production of the United States are presented on later pages of this report, but in the following table an interesting comparison is made between the annual production of iron ore and of pig iron:

*Production of iron ore and pig iron in the United States, 1889–1911, in long tons.*

| Year. | Iron ore produced.[a] | Pig iron produced.[b] | Percentage ratio of pig iron to iron ore. | Year. | Iron ore produced.[a] | Pig iron produced.[b] | Percentage ratio of pig iron to iron ore. |
|---|---|---|---|---|---|---|---|
| 1889 | 14,518,041 | 7,603,642 | 52.4 | 1901 | 28,887,479 | 15,878,354 | 54.9 |
| 1890 | 16,036,043 | 9,202,703 | 57.4 | 1902 | 35,554,135 | 17,821,307 | 50.1 |
| 1891 | 14,591,178 | 8,279,870 | 56.7 | 1903 | 35,019,308 | 18,009,252 | 51.4 |
| 1892 | 16,296,666 | 9,157,000 | 56.2 | 1904 | 27,644,330 | 16,497,033 | 59.7 |
| 1893 | 11,587,629 | 7,124,502 | 61.5 | 1905 | 42,526,133 | 22,992,380 | 54.0 |
| 1894 | 11,879,679 | 6,657,388 | 56.0 | 1906 | 47,749,728 | 25,307,191 | 53.0 |
| 1895 | 15,957,614 | 9,446,308 | 59.2 | 1907 | 51,720,619 | 25,781,361 | 49.8 |
| 1896 | 16,005,449 | 8,623,127 | 53.8 | 1908 | 35,924,771 | 15,936,018 | 44.3 |
| 1897 | 17,518,046 | 9,652,680 | 55.1 | 1909 | 51,155,437 | 25,795,471 | 50.4 |
| 1898 | 19,433,716 | 11,773,934 | 60.6 | 1910 | 56,889,734 | 26,674,123 | 46.9 |
| 1899 | 24,683,173 | 13,620,703 | 55.2 | 1911 | 40,989,808 | 23,257,288 | 56.7 |
| 1900 | 27,553,161 | 13,789,242 | 50.0 | | | | |

[a] Prior to 1908, iron ore used for fluxing included in production. Such ore excluded 1908–1911. Iron ore sold for paint excluded from 1910 and 1911 production and included in metallic paint. Iron ore marketed in 1911.

[b] From annual reports of the American Iron and Steel Association prior to 1910, and including ferro-alloys produced in blast furnaces. Figures for 1910 and 1911 represent pig iron sold or used (not quantity produced) and do not include ferro-alloys. Statistics for 1910 and 1911 were collected by the Survey.

## IRON-ORE INDUSTRY IN THE LAKE SUPERIOR DISTRICT.

*Production of iron ore in the Lake Superior district, by ranges.*—The Lake Superior district includes the Vermilion, Mesabi, Cuyuna, Penokee-Gogebic, Marquette, and Menominee ranges in the States of Minnesota, Michigan, and Wisconsin. The Menominee range includes the Crystal Falls, Metropolitan, Iron River, and Florence areas; the Marquette range includes the Republic and Swanzy areas. The Baraboo and Iron Ridge areas of southern Wisconsin and the Spring Valley area of northwestern Wisconsin are frequently also included in the Lake Superior district. In the first group of ranges the ore mined is almost entirely Algonkian hematite, belonging to the Huronian series. The Baraboo ore is of the same nature, but the Iron Ridge ore is Clinton hematite, and the Spring Valley ore is brown ore.

In addition to these ranges, there are several iron-ore districts on the Canadian side of the Great Lakes, the principal ones of which are the Michipicoten, the Animikie, the Matawin, and the Atikokan.

The American ranges which produced ore in 1911 were the Vermilion, Mesabi, Penokee-Gogebic, Marquette, Menominee, and Cuyuna, besides the Baraboo and Iron Ridge areas. Much development work was done on the Cuyuna range, which made its first shipments in 1911. The following table shows the production of the first six of these for 1910 and 1911, as they constitute the Lake Superior district proper.

The Mesabi range produced 67.6 per cent of the entire Lake Superior output and about 54 per cent of the entire production of the United States. The Menominee, Marquette, and Penokee-Gogebic ranges are next in importance, the Menominee producing a little more than the State of Alabama, which is the next State in importance as a producer after Minnesota and Michigan. The Vermilion range, the fifth in importance of the six producing Lake Superior ranges, produced more ore in 1911 than New York, which is fourth in importance as a producing State.

In the following tables is shown the total production of the Lake Superior district by ranges. The figures prior to 1872 were collected by A. P. Swineford, editor Marquette Mining Journal;[1] those for 1872 to 1877, inclusive, are from the Michigan Mineral Statistics; those from 1878 to 1888, inclusive, were collected by W. J. Stevens;[2] and the later figures were collected by the United States Geological Survey.

*Production of iron ore in the Lake Superior region, 1910–11, by ranges, in long tons.*

| Range. | 1910 | 1911 *a* | Increase (+) or decrease (−) in 1911. | Percentage of increase (+) or decrease(−) in 1911. | Percentage of total production in Lake Superior region. |
|---|---|---|---|---|---|
| Marquette (Michigan) | 4,631,427 | 2,820,749 | − 1,810,678 | −39.10 | 8.60 |
| Menominee (Michigan and Wisconsin) | 4,983,729 | 3,965,859 | − 1,017,870 | −20.42 | 12.10 |
| Gogebic (Michigan and Wisconsin) | 4,746,818 | 2,598,149 | − 2,148,669 | −45.27 | 7.92 |
| Vermilion (Minnesota) | 1,390,360 | 1,090,874 | − 299,486 | −21.54 | 3.33 |
| Mesabi (Minnesota) | 30,576,409 | 22,160,101 | − 8,416,308 | −27.53 | 67.60 |
| Cuyuna (Minnesota) | ..... | 147,431 | + 147,431 | ..... | .45 |
| Total | 46,328,743 | 32,783,163 | −13,545,580 | −29.24 | 100.00 |

*a* Shipments.

[1] Mineral Resources U. S. for 1882, p. 116.

[2] Mineral Resources U. S. for 1891, p. 41.

*Production of Lake Superior iron ore, 1854–1911, by ranges, in long tons.*

| Year. | Marquette. | Menominee. | Gogebic. | Vermilion. | Mesabi. | Cuyuna. | Total. |
|---|---|---|---|---|---|---|---|
| 1854–1869 | 3,112,209 | ..... | ..... | ..... | ..... | ..... | 3,112,209 |
| 1870 | 859,507 | ..... | ..... | ..... | ..... | ..... | 859,507 |
| 1871 | 813,984 | ..... | ..... | ..... | ..... | ..... | 813,984 |
| 1872 | 948,553 | ..... | ..... | ..... | ..... | ..... | 948,553 |
| 1873 | 1,195,234 | ..... | ..... | ..... | ..... | ..... | 1,195,234 |
| 1874 | 899,934 | ..... | ..... | ..... | ..... | ..... | 899,934 |
| 1875 | 881,166 | ..... | ..... | ..... | ..... | ..... | 881,166 |
| 1876 | 993,311 | ..... | ..... | ..... | ..... | ..... | 993,311 |
| 1877 | 1,014,754 | 10,375 | ..... | ..... | ..... | ..... | 1,025,126 |
| 1878 | 1,033,082 | 78,028 | ..... | ..... | ..... | ..... | 1,111,110 |
| 1879 | 1,130,019 | 245,672 | ..... | ..... | ..... | ..... | 1,375,691 |
| 1880 | 1,384,010 | 524,735 | ..... | ..... | ..... | ..... | 1,908,745 |
| 1881 | 1,579,834 | 726,671 | ..... | ..... | ..... | ..... | 2,306,505 |
| 1882 | 1,829,394 | 1,136,018 | ..... | ..... | ..... | ..... | 2,965,412 |
| 1883 | 1,305,364 | 1,047,863 | ..... | ..... | ..... | ..... | 2,353,227 |
| 1884 | 1,559,912 | 895,634 | 1,022 | 62,122 | ..... | ..... | 2,518,690 |
| 1885 | 1,430,862 | 690,435 | 119,590 | 227,075 | ..... | ..... | 2,467,962 |
| 1886 | 1,627,383 | 880,006 | 756,237 | 307,948 | ..... | ..... | 3,571,574 |
| 1887 | 1,851,717 | 1,199,343 | 1,285,265 | 394,910 | ..... | ..... | 4,731,235 |
| 1888 | 1,918,672 | 1,191,097 | 1,433,689 | 511,953 | ..... | ..... | 5,055,411 |
| 1889 | 2,631,026 | 1,876,157 | 2,147,923 | 864,508 | ..... | ..... | 7,519,614 |
| 1890 | 2,863,848 | 2,274,192 | 2,914,081 | 891,910 | ..... | ..... | 8,944,031 |
| 1891 | 2,778,482 | 1,856,124 | 2,041,754 | 945,105 | ..... | ..... | 7,621,465 |
| 1892 | 2,848,552 | 2,402,195 | 3,058,176 | 1,226,220 | 29,245 | ..... | 9,564,388 |
| 1893 | 2,064,827 | 1,563,049 | 1,466,815 | 815,735 | 684,194 | ..... | 6,594,620 |
| 1894 | 1,935,379 | 1,255,255 | 1,523,451 | 1,055,229 | 1,913,234 | ..... | 7,682,548 |
| 1895 | 1,982,080 | 1,794,970 | 2,625,475 | 1,027,103 | 2,839,350 | ..... | 10,268,978 |
| 1896 | 2,418,846 | 1,763,235 | 2,100,398 | 1,200,907 | 3,082,973 | ..... | 10,566,359 |
| 1897 | 2,673,785 | 1,767,220 | 2,163,088 | 1,381,278 | 4,220,151 | ..... | 12,205,522 |
| 1898 | 2,987,930 | 2,275,664 | 2,552,205 | 1,125,538 | 4,837,971 | ..... | 13,779,308 |
| 1899 | 3,634,596 | 3,281,422 | 2,725,648 | 1,643,984 | 6,517,305 | ..... | 17,802,955 |
| 1900 | 3,945,068 | 3,680,738 | 3,104,033 | 1,675,949 | 8,158,450 | ..... | 20,564,238 |
| 1901 | 3,597,089 | 3,697,408 | 3,041,869 | 1,805 996 | 9,303,541 | ..... | 21,445,903 |
| 1902 | 3,734,712 | 4,421,250 | 3,683,792 | 2,057,532 | 13,080,118 | ..... | 26,977,404 |
| 1903 | 3,686,214 | 4,093,320 | 3,422,341 | 1,918,584 | 13,452,812 | ..... | 26,573,271 |
| 1904 | 2,465,448 | 2,871,130 | 2,132,898 | 1,056,430 | 11,672,405 | ..... | 20,198,311 |
| 1905 | 3,772,645 | 4,472,630 | 3,344,551 | 1,578,626 | 20,156,566 | ..... | 33,325,018 |
| 1906 | 4,070,914 | 4,962,357 | 3,484,023 | 1,794,186 | 23,564,891 | ..... | 37,876,371 |
| 1907 | 4,167,810 | 4,779,592 | 3,609,519 | 1,724,217 | 27,245,441 | ..... | 41,526,579 |
| 1908 | 3,309,917 | 2,904,011 | 3,241,931 | 927,206 | 17,725,014 | ..... | 28,108,079 |
| 1909 | 4,291,967 | 4,789,362 | 3,807,157 | 1,097,444 | 27,877,705 | ..... | 41,863,635 |
| 1910 | 4,631,427 | 4,983,729 | 4,746,818 | 1,390,360 | 30,576,409 | ..... | 46,328,743 |
| 1911[a] | 2,820,749 | 3,965,859 | 2,598,149 | 1,090,874 | 22,160,101 | 147,431 | 32,783,163 |
| Total | 100,682,212 | 80,356,746 | 69,131,898 | 31,798,929 | 249,097,876 | 147,431 | 531,215,092 |

[a] Shipments.

*Shipments and receipts of Lake Superior ore.*— According to the Iron Trade Review 32,793,130 long tons of iron ore were shipped from the Lake Superior district. Of this total 662,719 tons were shipped by rail, the remainder being by boat. In 1911 the Survey statistics are based on marketed ore, which is practically the same as shipments in the case of the Lake ores, consequently the total given below for 1911 agrees closely with the figures as reported to the Survey. Details concerning the shipments and receipts of these ores are given in the following tables:

*Shipments of Lake Superior iron ore, 1906–1911, in long tons.*[a]

| Shipping port. | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|---|
| Escanaba, Mich | 5,851,050 | 5,761,988 | 3,351,502 | 5,747,801 | 4,949,726 | 4,278,445 |
| Marquette, Mich | 2,791,033 | 3,013,826 | 1,487,487 | 2,909,451 | 3,248,516 | 2,200,380 |
| Ashland, Wis | 3,388,106 | 3,436,867 | 2,513,670 | 3,834,207 | 4,094,374 | 2,429,290 |
| Two Harbors, Minn | 8,180,125 | 8,188,906 | 5,702,237 | 9,181,132 | 8,271,177 | 6,367,537 |
| Superior, Wis | 6,083,057 | 7,440,386 | 3,564,030 | 6,540,505 | 8,414,799 | 9,920,490 |
| Duluth, Minn | 11,220,218 | 13,448,736 | 8,808,168 | 13,470,503 | 13,640,166 | 6,934,269 |
| Total by lake | 37,513,589 | 41,290,709 | 25,427,094 | 41,683,599 | 42,618,758 | 32,130,411 |
| Total by rail | 1,052,173 | 975,959 | 587,893 | 903,270 | 823,639 | 662,719 |
| Total | 38,565,762 | 42,266,668 | 26,014,987 | 42,586,869 | 43,442,397 | 32,793,130 |

[a] Iron Trade Review.

*Iron-ore receipts at Lake Erie ports, 1906–1911, in long tons.*[a]

| Port. | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|---|
| Toledo | 1,423,741 | 1,314,140 | 680,553 | 1,374,224 | 1,225,202 | 493,345 |
| Sandusky | 35,847 | 83,043 | ..... | 11,088 | ..... | ..... |
| Huron | 778,453 | 971,430 | 213,377 | 243,082 | 197,951 | 223,947 |
| Lorain | 2,191,965 | 2,621,025 | 2,286,388 | 2,796,856 | 2,884,738 | 2,937,605 |
| Cleveland | 6,604,661 | 6,495,998 | 4,240,815 | 6,051,342 | 6,344,943 | 4,584,211 |
| Fairport | 1,861,498 | 2,437,649 | 1,518,961 | 1,734,277 | 1,516,434 | 666,365 |
| Ashtabula | 6,833,352 | 7,521,859 | 3,012,064 | 8,056,941 | 9,620,638 | 6,359,131 |
| Conneaut | 5,432,370 | 5,875,937 | 4,798,631 | 7,007,834 | 6,309,548 | 6,931,278 |
| Erie | 1,986,539 | 2,294,239 | 828,502 | 1,235,057 | 942,592 | 289,400 |
| Buffalo | 4,928,381 | 5,580,438 | 2,835,099 | 5,002,235 | 4,704,439 | 2,802,976 |
| Detroit | ..... | ..... | ..... | 159,889 | 296,412 | 243,292 |
| Total | 32,076,757 | 35,195,758 | 20,414,491 | 33,672,825 | 34,042,897 | 25,531,550 |

[a] Iron Trade Review.

The difference between the shipments of Lake Superior ore and the receipts at Lake Erie ports is accounted for mainly by the quantity of ore delivered at Lake Michigan ports, Chicago, Ill., Gary, Ind., and Milwaukee, Wis.

The following table shows the total quantity of iron ore shipped from the Lake Superior district since 1854, the date of the opening of the Marquette range, the oldest of the Lake Superior ranges. This table gives the shipments as collected by the Iron Trade Review and is inserted for comparison with the table giving the total production of the Lake Superior district, without regard to shipments:

*Shipments of iron ore from the Lake Superior region, 1854–1911, in long tons.*

| Year. | Quantity. | Year. | Quantity. | Year. | Quantity. |
|---|---|---|---|---|---|
| 1854 | 3,000 | 1874 | 919,557 | 1894 | 7,748,932 |
| 1855 | 1,449 | 1875 | 891,257 | 1895 | 10,429,037 |
| 1856 | 36,343 | 1876 | 992,764 | 1896 | 9,934,828 |
| 1857 | 25,646 | 1877 | 1,015,087 | 1897 | 12,469,638 |
| 1858 | 15,876 | 1878 | 1,111,110 | 1898 | 14,024,673 |
| 1859 | 68,832 | 1879 | 1,375,691 | 1899 | 18,251,804 |
| 1860 | 114,401 | 1880 | 1,908,745 | 1900 | 19,059,393 |
| 1861 | 49,909 | 1881 | 2,306,505 | 1901 | 20,589,237 |
| 1862 | 124,169 | 1882 | 2,965,412 | 1902 | 27,571,121 |
| 1863 | 203,055 | 1883 | 2,353,288 | 1903 | 24,289,878 |
| 1864 | 243,127 | 1884 | 2,518,692 | 1904 | 21,822,839 |
| 1865 | 236,208 | 1885 | 2,466,372 | 1905 | 34,384,116 |
| 1866 | 278,796 | 1886 | 3,568,022 | 1906 | 38,565,762 |
| 1867 | 473,567 | 1887 | 4,730,577 | 1907 | 42,266,668 |
| 1868 | 491,449 | 1888 | 5,063,693 | 1908 | 26,014,987 |
| 1869 | 617,444 | 1889 | 7,292,754 | 1909 | 42,586,869 |
| 1870 | 830,940 | 1890 | 9,012,379 | 1910 | 43,442,397 |
| 1871 | 779,607 | 1891 | 7,062,233 | 1911 | 32,793,130 |
| 1872 | 900,901 | 1892 | 9,069,556 | | |
| 1873 | 1,162,458 | 1893 | 6,060,492 | Total | 525,586,672 |

*Stocks of iron ore at Lake Erie ports.*—At the close of navigation in 1910 the stocks of iron ore at the Lake Erie ports exceeded those of the same date in 1909 by 461,092 tons, and the stocks of 1909 exceeded those of 1908 by 524,256 tons, but in 1911 the stocks amounted to 295,217 tons less than in 1910.

The following tables contain data as to the stocks of iron ore at the Lake Erie ports at the close of navigation and at the opening of navigation for the last six years:

*Stocks of iron ore at lower Lake ports, Dec. 1, 1906–1911, in long tons.*[a]

| Port. | At close of navigation, Dec. 1— | | | | | |
|---|---|---|---|---|---|---|
| | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 |
| Toledo, Ohio | 281,000 | 518,645 | 590,925 | 332,456 | 433,215 | 661,382 |
| Sandusky, Ohio | 17,467 | 44,546 | 36,079 | 39,557 | 17,728 | 2,471 |
| Huron, Ohio | 245,499 | 415,730 | 458,158 | 477,333 | 375,118 | 344,371 |
| Lorain, Ohio | 336,321 | 366,271 | 426,274 | 407,129 | 259,448 | 314,321 |
| Cleveland, Ohio | 1,224,606 | 1,281,335 | 1,458,392 | 1,547,142 | 1,638,795 | 1,589,491 |
| Fairport, Ohio | 590,783 | 523,981 | 835,821 | 867,640 | 839,970 | 636,566 |
| Ashtabula, Ohio | 1,631,312 | 2,056,820 | 2,293,531 | 2,594,359 | 3,287,816 | 3,295,862 |
| Conneaut, Ohio | 1,057,424 | 1,000,774 | 1,296,675 | 1,411,002 | 1,329,997 | 1,237,573 |
| Erie, Pa | 552,631 | 652,219 | 730,530 | 788,046 | 792,011 | 636,274 |
| Buffalo, N. Y | 315,412 | 435,407 | 315,148 | 501,125 | 452,783 | 413,353 |
| Total | 6,252,455 | 7,385,728 | 8,441,533 | 8,965,789 | 9,426,881 | 9,131,664 |

[a] Iron Trade Review.

*Stocks of iron ore at lower Lake ports, May 1, 1906–1912, in long tons.*[a]

| Port. | At opening of navigation, May 1— | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 | 1912 |
| Ashtabula, Ohio | 462,564 | 568,485 | 1,799,454 | 1,392,430 | 1,609,931 | 2,277,931 | 2,108,749 |
| Cleveland, Ohio | 350,382 | 447,573 | 1,029,198 | 1,018,055 | 985,725 | 1,502,858 | 1,363,696 |
| Fairport, Ohio | 266,162 | 154,246 | 225,328 | 562,679 | 541,299 | 633,485 | 381,705 |
| Erie, Pa | 169,488 | 189,276 | 595,660 | 557,029 | 550,187 | 653,778 | 585,150 |
| Lorain, Ohio | 140,452 | 176,300 | 327,052 | 362,096 | 205,445 | 346,849 | 287,294 |
| Conneaut, Ohio | 148,528 | 139,853 | 462,392 | 497,203 | 461,365 | 419,421 | 229,462 |
| Toledo, Ohio | 52,550 | 147,397 | 217,788 | 380,675 | 366,631 | 383,761 | 356,102 |
| Huron, Ohio | 80,738 | 98,106 | 392,731 | 379,364 | 336,693 | 273,042 | 257,496 |
| Buffalo, N. Y | 90,906 | 50,313 | 388,441 | 189,209 | 364,336 | 347,702 | 309,120 |
| Sandusky, Ohio | 29,320 | 5,439 | 42,256 | 31,528 | 22,468 | 11,458 | 2,471 |
| Total | 1,791,090 | 1,976,988 | 5,480,300 | 5,370,268 | 5,444,080 | 6,850,285 | 5,881,245 |

[a] Iron Trade Review.

*Prices of Lake Superior iron ore.*—In the following table are given the prices of Lake Superior iron ore at the lower Lake ports during 1910 and 1911.

The base for the Bessemer ore is a metallic iron content of 55 per cent; that of the non-Bessemer ore is a metallic iron content of 51.5 per cent:

*Base prices per long ton of Lake Superior iron ore at lower Lake ports, 1910–11.*

| | 1910 [a] | 1911 [b] | | 1910 [a] | 1911 [c] |
|---|---|---|---|---|---|
| Old range: | | | Mesabi: | | |
| Bessemer | $5.00 | $4.50 | Bessemer | $4.75 | $4.25 |
| Non-Bessemer | 4.20 | 3.70 | Non-Bessemer | 4.00 | 3.50 |

[a] Iron Trade Review, Jan. 13, 1910.
[b] Bull. Am. Iron and Steel Assoc. for 1910, p. 36.
[c] Iron Trade Review, Jan. 4, 1912, p. 29.

*Cuyuna range.*—With the advent of the Cuyuna range into the producing field the following brief note on the condition of developments and the outlook at the close of 1911 is of interest:[1]

In the past year the first shipments of iron ore from the Cuyuna range in Minnesota have been made. The total amount moved was 147,000 tons, taken from the Kennedy

[1] Woodbridge, D. E., Lake Superior ore developments: Iron Age, Jan. 4, 1912, p. 67.

mine of the Rogers-Brown Ore Co. and shipped over the new branch of the Soo Line to the new ore docks of that road at Superior, Wis. The ore shipped was representative of the average product that may be expected to come from this district in the next few years, although an important portion of the tonnage so far proved up will run considerably higher in iron content. The shipments of the past year averaged between 45 and 46 per cent metallic iron, natural, and in other constituents and characteristics the ore was decidedly desirable. The plans for shipments next year contemplate the movement of 200,000 tons from the Kennedy mine, 100,000 tons from the Armour mine, owned by the Iroquois Iron Co., and a like amount from the Thompson mine of the Inland Steel Co. This iron is expected to grade from 46 per cent in iron, natural, up to 51 per cent.

* * * The iron formation of this district embraces two ranges, known as the North and the South. While the Adams syndicate is now actively engaged in sinking a concrete shaft on the South range at a property drilled and abandoned by the Rogers-Brown Ore Co., and M. A. Hanna & Co. are exploring a property southwest of Brainard, the major portion of the year's development has been confined to the North range. In addition to the operation of its Kennedy mine, the Rogers-Brown Ore Co. put down a concrete shaft on its Meacham property. After the sinking of the shaft development work on this property was discontinued pending an improvement in the condition of the ore market. This company is also conducting the development work of the Armour mine mentioned above. On the forty adjoining that of the Armour deposit the Inland Steel Co. has put down a concrete shaft, and more recently Oglebay, Norton & Co., Cleveland, have taken over a proved deposit from the C. M. Hill Lumber Co. and are now checking the drill holes preparatory to putting down a shaft.

Conditions thus far encountered have made it advisable hereafter to build shafts of concrete, which work has been done by the Foundation Co. of New York. The development work of the year has served to establish somewhat more clearly the character of the Cuyuna ore-bearing formation. The feeling has existed in the past that drilling for ore in this field was largely a hit or miss proposition. This is still true to a degree because of the peculiar interruptions of the continuity of the ore lenses. The general trend of the North range has been followed as far as Mississippi River. It is not continuous, however, but consists of parallel lenses of irregular location and extent. The ore formation stands at an angle of from 50° to 70°, and the ore bodies, although they may easily be missed by drill, admit of opening up and working to advantage.

## FOREIGN TRADE IN IRON ORE.

### IMPORTS.

The quantity of iron ore imported into the United States in 1911 was 1,811,732 long tons, valued at $5,412,636, or $2.99 per ton. This represents a decrease in quantity of 779,299 tons (30 per cent) and in value of $2,419,589, as compared with the imports during 1910, which were 2,591,031 long tons, valued at $7,832,225, or $3.02 per ton. The imports in 1910 increased 53 per cent over those of 1909, and the sudden checking of the imports in 1911 indicates how closely the course of imports parallels the local production. As to the source of the imports in 1911, Cuba produced 63 per cent of the ore, Sweden 12 per cent, Spain 11 per cent, Newfoundland and Labrador 10 per cent, Canada 3 per cent, with minor quantities from Greece, French Africa, Great Britain, the Netherlands, and other countries.

The statistics of imports of iron ore are furnished by the Bureau of Statistics, Department of Commerce and Labor, and the following table gives the imports from the various countries from 1908 to 1911:

*Quantity and value of iron ore imported into the United States in the calendar years 1908–1911, by countries, in long tons.*

| Country. | 1908 | | 1909 | | 1910 | | 1911 | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Cuba | 579,668 | $1,756,091 | 927,774 | $2,681,028 | 1,451,096 | $4,459,789 | 1,147,879 | $3,218,485 |
| Spain | 126,074 | 331,070 | 291,547 | 664,460 | 439,868 | 1,040,589 | 194,965 | 502,453 |
| French Africa | | | 37,208 | 67,515 | 15,471 | 36,791 | 4,443 | 13,068 |
| Greece | 4,850 | 5,311 | 19,080 | 21,782 | 39,060 | 71,951 | 13,200 | 18,888 |
| Newfoundland and Labrador | 48,285 | 48,285 | 224,395 | 330,056 | 209,006 | 343,892 | 174,853 | 286,997 |
| United Kingdom | 2,028 | 32,027 | 869 | 12,846 | 11,388 | 52,591 | 1,436 | 19,725 |
| Germany | 602 | 4,052 | 3 | 100 | 3 | 58 | 2 | 76 |
| Netherlands | | | | | | | 223 | 420 |
| Canada | 5,013 | 16,321 | 27,155 | 84,613 | 95,005 | 251,086 | 50,480 | 106,038 |
| Belgium | 1 | 28 | 3 | 179 | 158 | 644 | | |
| Russia in Europe | | | 32,010 | 62,418 | 12,570 | 48,279 | | |
| Sweden | 4,617 | 15,783 | 120,564 | 627,315 | 259,911 | 1,391,976 | 219,238 | 1,215,588 |
| Other countries | 5,760 | 15,280 | [a] 14,349 | 26,766 | [b] 57,495 | 134,579 | 5,013 | 30,898 |
| Total | 776,898 | 2,224,248 | 1,694,957 | 4,579,078 | 2,591,031 | 7,832,225 | 1,811,732 | 5,412,636 |

[a] Other countries in 1909: Colombia and Mexico.
[b] Other countries in 1910: Chinese Empire, Colombia, Egypt, British South Africa, etc.

The following table shows the imports of iron ore into the United States from 1907 to 1911, inclusive, by ports of entry:

*Quantity and value of iron ore imported into the United States in the calendar years 1908–1911, by customs districts, in long tons.*

| Customs district. | 1908 | | 1909 | | 1910 | | 1911 | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Baltimore | 248,875 | $844,436 | 628,577 | $1,838,762 | 1,137,916 | $3,575,059 | 806,354 | $2,305,042 |
| Boston | 21 | 61 | 7 | 29 | 235 | 853 | 100 | 272 |
| Charleston | 500 | 3,070 | | | | | | |
| New York | 4,392 | 17,424 | 47,285 | 93,277 | 78,556 | 213,282 | 11,263 | 32,077 |
| Perth Amboy | 1,355 | 23,637 | | | | | | |
| Philadelphia | 516,619 | 1,318,182 | 991,983 | 2,559,760 | 1,269,180 | 3,775,770 | 984,192 | 3,039,994 |
| Savannah | | | | | | | | |
| Chicago | | | | | 7,679 | 22,610 | | |
| Los Angeles | 51 | 501 | | | | | | |
| Puget Sound | | | | | 25,000 | 47,750 | | |
| San Francisco | 50 | 446 | | | | | 10 | 250 |
| Buffalo Creek | | | 141 | 489 | 4,200 | 4,473 | 2,730 | 5,255 |
| Champlain | 10 | 30 | 40 | 75 | 29 | 73 | 146 | 1,904 |
| Cuyahoga | 1,712 | 3,030 | 3,500 | 15,250 | | | 2,902 | 6,675 |
| Detroit | | | 25 | 777 | 306 | 765 | 23 | 105 |
| Erie | | | 4,000 | 16,700 | | | | |
| Miami | 2,569 | 9,403 | 18,106 | 46,106 | 63,966 | 172,824 | | |
| Niagara | 23 | 40 | 596 | 2,310 | 2,343 | 11,166 | 1,668 | 8,343 |
| Oswegatchie | 23 | 60 | | | 25 | 75 | 50 | 150 |
| Vermont | 676 | 3,758 | 455 | 2,054 | 137 | 1,509 | 47 | 188 |
| St. Louis | 22 | 170 | | | | | 70 | 1,034 |
| Genesee | | | 17 | 895 | 10 | 553 | 13 | 527 |
| Other dstricts | | | 225 | 2,594 | 1,449 | 5,463 | 2,164 | 10,820 |
| Total | 776,898 | 2,224,248 | 1,694,957 | 4,579,078 | 2,591,031 | 7,832,225 | 1,811,732 | 5,412,636 |

In the following table is shown the importation of iron ore into the United States as far as has been recorded. Iron ore was imported from Europe in large quantities for the first time in 1879, most of the ore prior to that date coming from Canada:

*Imports of iron ore into the United States, 1872–1911, in long tons.*

| Year. | Quantity. | Year. | Quantity. | Year. | Quantity. |
|---|---|---|---|---|---|
| 1872 | 23,733 | 1885 | 390,786 | 1899 | 674,082 |
| 1873 | 45,981 | 1886 | 1,039,433 | 1900 | 897,831 |
| 1874 | 57,987 | 1887 | 1,194,301 | 1901 | 966,950 |
| 1875 | 56,655 | 1888 | 587,470 | 1902 | 1,165,470 |
| 1876 | 17,284 | 1889 | 853,573 | 1903 | 980,440 |
| 1877 | 30,669 | 1890 | 1,246,830 | 1904 | 487,613 |
| 1878 | 28,212 | 1891 | 912,864 | 1905 | 845,651 |
| 1879 [a] | 150,197 | 1892 | 806,585 | 1906 | 1,060,390 |
| 1879 [b] | 284,141 | 1893 | 526,951 | 1907 | 1,229,168 |
| 1880 | 493,408 | 1894 | 167,307 | 1908 | 776,898 |
| 1881 | 782,887 | 1895 | 524,153 | 1909 | 1,694,957 |
| 1882 | 589,655 | 1896 | 682,806 | 1910 | 2,591,031 |
| 1883 | 490,875 | 1897 | 489,970 | 1911 | 1,811,732 |
| 1884 | 487,820 | 1898 | 187,208 | | |

[a] Fiscal years end. [b] Calendar years begin.

## EXPORTS.

The quantity of iron ore exported from the United States in 1911 amounted to 768,386 long tons, an increase of about 3 per cent over iron-ore exports in 1910. The exports were valued at $2,653,448, or $3.45 per ton, in 1911.

In the following table is shown the exportation of iron ore from the United States, by customs districts, from 1908 to 1911, inclusive. The data regarding exports are furnished by the Bureau of Statistics, Department of Commerce and Labor.

*Quantity and value of iron ore exported from the United States in the calendar years 1908–1911, by customs districts, in long tons.*

| Customs district. | 1908 | | 1909 | | 1910 | | 1911 | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| New York | ..... | ..... | ..... | ..... | ..... | ..... | 10 | $68 |
| Savannah | ..... | ..... | ..... | ..... | 10 | $75 | ..... | ..... |
| Norfolk and Portsmouth | ..... | ..... | 3 | $27 | ..... | ..... | 37 | 357 |
| Saluria | ..... | ..... | ..... | ..... | ..... | ..... | 4,175 | 9,412 |
| Buffalo Creek | 25 | $140 | 336 | 1,506 | 1,203 | 6,054 | 2,115 | 10,575 |
| Champlain | 7,359 | 22,517 | 9,417 | 27,170 | 19,941 | 71,740 | 13,583 | 49,278 |
| Detroit | 4 | 46 | ..... | ..... | ..... | ..... | ..... | ..... |
| Duluth | 52,509 | 187,059 | 129,231 | 471,088 | 187,042 | 650,654 | 75,232 | 265,360 |
| Niagara | 3,097 | 7,289 | 6,887 | 21,819 | 2,848 | 12,956 | 369 | 1,550 |
| Superior | 244,408 | 789,306 | 306,270 | 830,415 | 519,396 | 1,683,824 | 657,895 | 2,286,908 |
| Vermont | 1,697 | 6,567 | ..... | ..... | ..... | ..... | ..... | ..... |
| Puget Sound | ..... | ..... | 3,790 | 13,300 | 18,435 | 48,861 | 14,970 | 29,940 |
| Total | 309,099 | 1,012,924 | 455,034 | 1,365,325 | 748,875 | 2,474,164 | 768,386 | 2,653,448 |

The quantity of iron ore exported from the United States, so far as recorded, is shown in the following table:

*Exports of iron ore from the United States, 1899–1911, in long tons.*

| Year. | Quantity. | Year. | Quantity. |
|---|---|---|---|
| 1899 | 40,665 | 1906 | 265,240 |
| 1900 | 51,460 | 1907 | 278,608 |
| 1901 | 64,703 | 1908 | 309,099 |
| 1902 | 88,445 | 1909 | 455,934 |
| 1903 | 80,611 | 1910 | 748,875 |
| 1904 | 213,865 | 1911 | 768,386 |
| 1905 | 208,017 | | |

## IRON-ORE INDUSTRY OF CUBA.

The iron ores which were mined in Cuba prior to 1910 consisted largely of hematite and magnetite and were obtained near Santiago, in the Province of Oriente (Santiago). Recently large deposits of brown ore have been attracting considerable attention, especially those of the Mayari and the Moa fields, in Oriente Province, and those of the Cubitas field, in Camaguey Province. The brown ore shipped, 307,700 tons in 1910 and 387,791 tons in 1911, was from the Mayari field, in Oriente. Several interesting papers were published by the American Institute of Mining Engineers on Cuban iron ores in 1911, and these are listed in the bibliography at the end of this chapter.

The following table shows the shipments of iron ore from Cuba since the opening of the mines in 1884. The statistics of the Cuban iron-ore shipments were collected by the United States Geological Survey.

*Shipments of iron ore from mines in the Province of Oriente (Santiago), Cuba, 1884–1911, in long tons.*

| Year. | Juragua Iron Co. (Ltd.). | Sigua Iron Co. | Spanish-American Iron Co. | Cuban Steel Ore Co. | Ponupo Manganese Co. | Total. |
|---|---|---|---|---|---|---|
| 1884 | 25,295 | | | | | 25,295 |
| 1885 | 80,716 | | | | | 80,716 |
| 1886 | 112,074 | | | | | 112,074 |
| 1887 | 94,240 | | | | | 94,240 |
| 1888 | 206,061 | | | | | 206,061 |
| 1889 | 260,291 | | | | | 260,291 |
| 1890 | 363,842 | | | | | 363,842 |
| 1891 | 264,262 | | | | | 264,262 |
| 1892 | 335,236 | 6,418 | | | | 341,654 |
| 1893 | 337,155 | 14,020 | | | | 351,175 |
| 1894 | 156,826 | | | | | 156,826 |
| 1895 | 307,503 | | 74,991 | | | 382,494 |
| 1896 | 298,885 | | 114,110 | | | 412,995 |
| 1897 | [a] 248,256 | | [b] 206,029 | | | 454,285 |
| 1898 | 83,696 | | 84,643 | | | 168,339 |
| 1899 | 161,783 | | 215,406 | | | 377,189 |
| 1900 | 154,871 | | 292,001 | | | 446,872 |
| 1901 | 199,764 | | [c] 334,833 | 17,651 | | 552,248 |
| 1902 | 221,039 | | 455,105 | 23,590 | | 699,734 |
| 1903 | 155,898 | | 467,723 | | | 623,621 |
| 1904 | 31,162 | | 356,111 | | | 387,273 |
| 1905 | 139,828 | | 421,331 | | | 561,159 |
| 1906 | 133,379 | | 507,195 | | | 640,574 |
| 1907 | 181,063 | | 500,330 | | | 681,393 |
| 1908 | 366,580 | | 452,854 | | | 819,434 |
| 1909 | 356,659 | | 514,066 | | 59,721 | 930,446 |
| 1910 | 318,814 | | 978,676 | | 165,008 | 1,462,498 |
| 1911 | 355,132 | | 640,508 | | 168,074 | 1,163,714 |

[a] Of this quantity, 5,932 tons were sent to Pictou, Nova Scotia.
[b] Of this quantity, 51,537 tons were sent to foreign ports.
[c] Of this quantity, 12,691 tons were sent to foreign ports.

## PRODUCTION OF IRON ORE IN PRINCIPAL COUNTRIES.

The latest available statistics covering the output of iron ore in the principal producing countries are shown in the following table. Of the figures in this table, those for the United States, Great Britain, Cuba, Canada, India, and Australia are in long tons; those for the other countries are in metric tons.

*Production of iron ore in principal countries in 1908, 1909, and 1910.*

| Country. | 1908 | 1909 | 1910 |
|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* |
| Algeria | 943,424 | 891,000 | (a) |
| Australia | 55,194 | 48,636 | (a) |
| Austria-Hungary | 4,718,700 | 4,575,828 | (a) |
| Belgium | 188,780 | 199,710 | 122,960 |
| Canada | b 212,573 | b 239,324 | b 231,623 |
| China | c 133,458 | c 89,108 | (a) |
| Cuba | d 819,434 | d 930,446 | d 1,462,498 |
| France | 10,057,145 | 11,890,000 | (a) |
| Germany and Luxemburg | 24,278,151 | 25,504,464 | (a) |
| Greece | 531,368 | 475,616 | (a) |
| India | 72,300 | 83,456 | (a) |
| Italy | 539,120 | 505,095 | (a) |
| Japan e | (a) | (a) | (a) |
| Newfoundland | 935,154 | 1,004,050 | (a) |
| Norway | 119,656 | 40,389 | (a) |
| Russia f | (a) | (a) | (a) |
| Spain | 9,271,592 | 8,786,021 | (a) |
| Sweden | 4,713,160 | 3,886,060 | (a) |
| Tunis | 148,000 | 218,000 | (a) |
| United Kingdom | 15,031,025 | 14,804,382 | 15,226,015 |
| United States | 35,924,771 | 51,155,437 | 56,889,734 |

a Not yet available.
b Shipments. During 1911 Canada shipped 187,807 long tons of iron ore.
c Exports.
d Shipments.
e Japan produced 45,396 metric tons of pig iron in 1908, and 54,191 tons in 1909.
f Russia produced 2,824,474 metric tons of pig iron in 1908, and 2,622,419 tons in 1909.

## PROSPECTING FOR IRON ORE.

### GENERAL STATEMENT.

The United States Geological Survey has received many inquiries in the last few years with regard to methods of prospecting for iron ore, and in order to supply some information on this subject, outlines on prospecting for certain types of ore, such as hematite and limonite, are given below. Owing to the variety of ores and to the differences in local conditions of climate, topography, geologic associations, and structure, any set of suggestions can at best be only very general, but it is hoped that a few of the fundamental principles at least may be made clear.

Referring to page 8 for varieties of ores, it will be noted that hematite is the most common commercial ore of iron, followed in order by brown ore, or limonite, magnetite, and iron carbonate.

### PROSPECTING BY PITS AND DRILLS.

#### BEDDED HEMATITE.

The simplest form in which hematite occurs is in horizontal or gently inclined beds or lenses, such as are characteristic of the Clinton ore in west-central New York and in the Appalachian region of

Pennsylvania, Virginia, Tennessee, Georgia, and Alabama, also in Kentucky and Wisconsin. These beds range in thickness from a few inches to 10 or 12 feet, and in rare instances to 35 feet, and generally their outcrop may be found at intervals for many miles, if the associated formation, which consists mainly of shale, sandstone, and limestone, be followed. In places, especially in the southern Appalachians, the formation carrying the Clinton ore has been badly folded and broken by faults. In such situations the ore beds are generally steeply inclined and their edges have a very definite strike along the surface.

The first step in prospecting for bedded hematite is to determine, in places where the ore is known to be present, its approximate distance below the top of the inclosing formation. Naturally this will vary with the thickness of the whole formation. In the southern Appalachians the black Chattanooga shale overlies the Clinton formation. In Alabama the ore beds lie usually from 80 to 175 feet below the black shale, and in Tennessee the main ore bed lies generally from 60 to 200 feet below the black shale. Persons who are familiar with the Clinton ore and formation locally should be able to recognize the ore-bearing zone within narrow limits by means of some associated bed, such as a heavy sandstone, a crystalline limestone, a red shale, etc. In prospecting trenches or pits are dug at right angles to the strike of the formation, sufficiently deep to reach solid rock and wide enough for a man to stand in. In the southern Appalachians, where there is no glacial débris, weathering has affected the rocks to considerable depths, but on the hillsides where the Clinton ores outcrop erosion has removed the soil and clay nearly as fast as the weathering has advanced, so that the test pits rarely have to be dug more than 5 feet deep, and generally traces of the ore can be found at lesser depths. Where a bed of this ore is located near the surface it is generally "soft;" that is, leached of its lime carbonate; in addition, it may be so badly disintegrated by weathering that its true character is not apparent, and, further, foreign material may have worked in between the loosened grains; it is therefore not safe to sample any ore unless it is firm and unaltered. The ore should be followed by pit, slope, or tunnel far enough to reach an unaltered portion of the bed, if possible, and it is very desirable that the "hard" or limey ore should be reached, as samples of the hard ore yield the most reliable indication of the ultimate character of the ore in a given locality. A series of pits extending to the hard ore is also essential in determining the extent of the soft ore in the direction of the dip, the thickness of the soft and hard ores, the thickness of cover and other factors, such as the angle and direction of dip of the ore, all of which must be reckoned with in considering whether or not an ore bed is worth mining.

The foregoing notes apply only to hand prospecting at the surface. In developing Clinton iron ore on an important scale, it is necessary to determine whether the ore continues in workable thickness and character below the surface in the direction of the dip; whether the dip changes; whether faults may intervene through which the ore may be lost. Core drilling at distances of 1,000 to 3,000 feet or more from the outcrop has yielded much valuable information in the Birmingham district, and should be employed also in the Chattanooga

district and farther north. The importance of efficient drilling apparatus, of thorough and intelligent supervision of work, and of careful, accurate recording of drill logs can not be urged too strongly here. Unfortunately much money has in the past been wasted by ill-considered methods of drilling. Attempts have been made to drill deep holes with apparatus that was inadequate, and such holes have been mostly abandoned, without reaching ore. Holes have been drilled with the churn drill, which as the best yields very uncertain results. A core is absolutely necessary, if the true thickness, quality, and dip of the ore are to be determined. Many holes have been drilled, with both the churn drill and the core drill, the logs of which are preserved only in the memory of the driller, and the washings and cores from the ore beds were scattered to the winds without securing material for chemical analyses. The rocks above the Clinton ore consist of sandstone, limestone, cherty limestone and chert, and shale. All of these rocks except the shale are hard to drill. Both the diamond-bitted drill and the steel bit with crushed steel are proving successful in bringing up cores. The cores most satisfactory are those with diameters not less than 1¼ inches. Costs of drilling in the Appalachian Valley rocks range from $3 to $5 per foot, depending on the diameter of the core and the depth of the hole. A discussion of core drilling as applied to the Birmingham district has been given in an earlier Survey publication.[1]

### LIMONITE, OR BROWN ORE.

Under the head of brown ore are deposits of several different types. Probably the most common brown ores are (*a*) the residual and (*b*) the replacement ores of the mountain and valley regions from New England southwest through the Appalachians to Alabama and occurring to some extent in the Mississippi Valley. The residual ores occur in irregular masses, bowlders, pebbles, and sand, and as cementing material in beds of conglomerate. The masses and bowlders are usually imbedded in clay that is residual from limestone and lies on an uneven surface of limestone or dolomite. The ferruginous conglomerate overlies the irregular masses of brown ore and clay, and the gravelly and sandy ore forms a thin mantle in places over the lower deposits. The residual brown ores are in most places covered by sand, gravel, and soil, and in many places the surface is timbered. At the surface ledges of ore appear in places, especially in gullies, and ore gravel is often noted, but owing to the cover of barren material that is commonly present prospecting must be done in order to establish the presence of ore, its thickness, extent, and quality, and the thickness of the overburden. One common method of prospecting is by test wells sunk by hand, and the churn drill is also employed. Test wells as sunk in Alabama and Georgia are 30 to 36 inches in diameter, and if sunk in unconsolidated materials may reach depths of 50 feet. The cost of such pits should range from 35 to 50 cents a foot. If limestone is reached in a test well there is no need to sink it deeper, for no ore will be found, but if ore is reached it is of importance that the well should be sunk through the deposit, and this may be more difficult and costly work, especially if the ore is very hard.

[1] Burchard, E. F., The iron ores of the Birmingham district, Alabama; Bull. U. S. Geol. Survey No. 400, 1910, pp. 141–142.

Examples of tracts prospected by test wells and of the associated brown ore mines are described in a former Survey bulletin.[1] According to Geismer [2] the tools needed in sinking test wells by hand are a windlass, rope, bucket, and short-handled pick. Such holes, of about 30 inches diameter, can be sunk economically to depths not exceeding 30 feet, providing but little solid material is encountered. When rock is encountered blasting is necessary, and the small diameter of such holes does not permit a steel and hammer to be used to good effect, but if their diameter be increased the test wells become too expensive. In ordinary unconsolidated material two men will sink about 10 feet a day.

Geismer, in the paper cited, gives a practical discussion of churn drilling, from which the following passages are quoted:

*Boring with churn drills.*—In churn drilling, the property is covered with holes of about 6 inches diameter, to any required depths up to 500 or 600 feet. The holes are drilled rapidly, a good crew averaging about 50 feet per shift when in loose material, and 30 feet in rock, and the cost is less than by any other method. Any of the light types of standard churn drills are suitable, and either steam or gasolene power may be used. If the country is rather hilly, and water has to be hauled from a distance, the gasolene machine is to be preferred, as it is lighter and requires no water for boiler use; two or three barrels of water per shift will furnish such a machine with all that is required for cooling the engine, following the bit, and floating the drillings for the sand pump.

For general prospecting I prefer a light, nontraction, gasolene-driven machine, weighing about 6,000 pounds, exclusive of the gasolene engine. The holes required for brown-ore prospecting rarely exceed 150 feet depth and, as a rule, do not require casing, so that the lightest machine will stand up to the work. Unless the ground is level, the traction feature is of little advantage. For such machines a 6-horsepower engine is ample. In purchasing such machines it is advisable to get extra bits, as broken and loose bits often delay the work for days when no extra ones are at hand.

*Precaution in churn drilling.*—In using churn drills two precautions must be insisted on continually, or the results will be useless if not misleading.

(1) Bail the hole out clean with the sand pump every time the drill advances 3 feet. (2) Carefully examine the washings recovered by the sand pump for quantity and quality of ore contained.

If a bit is penetrating clay strata and suddenly encounters an ore bowlder, the first result will be to force the bowlder down into the soft clay that underlies it; gradually as this clay becomes more and more compact the bowlder will begin to crack, and finally the bit will force its way completely through it. Unless, therefore, the hole is carefully bailed at frequent intervals, the sample recovered at any particular depth may not represent the material being penetrated at that time, and it might be possible to recover the ore in the sand pump for some time after the actual ore deposit had been completely penetrated. Careful bailing of the hole after each 3 feet of drill advance will eliminate this chance of error and give accurate results.

In instructing drill operators for this class of work it is advisable to follow down the first few holes with wells, so that the driller may examine the strata foot by foot, and see exactly how they compare with what the drill led him to believe would be found. Similar test wells are also to be advised whenever the nature of the deposit changes considerably.

*Examination of the borings.*—The quantity and quality of the ore encountered by the drill, and the thickness of the ore deposit are determined as follows: Each time the bit advances 3 feet the hole is bailed out with the sand pump, and from the washings recovered by the pump a pailful is saved. This pailful is carefully sifted until all of the mud is separated from the rock (ore, etc.), and the rock material is then put into bags and sent to the laboratory to be analyzed. From these samples one can obtain a general idea of the quality of the ore that may be recovered from the deposit, provided certain allowances are made: If the washings contain much clay, the sample will be better than the ore mined, because no washer will make a complete separation of clay and ore; if the washings show considerable worthless rock or sand mixed with the ore, the sample will not be so good as the final product, because by means of jigs

[1] Burchard, E. F., The iron ores of the Birmingham district, Alabama: Bull. U. S. Geol. Survey No. 400, 1910, pp. 161–165.

[2] Geismer, H. S., Prospecting for brown iron ores: Eng. and Min. Jour., Sept. 9, 1911, pp. 498–500.

and picking belts the larger part of the rock and sand can be separated. Just how accurately the observer can allow for these characteristics will depend upon his experience.

As soon as the samples indicate that the lower limit of the ore has been reached, drilling is stopped and the exact depth of the hole is measured and recorded.

The relative quantity of ore per foot of depth is estimated by the amount of ore recovered from the bucketful of washings, and by occasional test wells following the drill holes. Such results may appear manifestly inaccurate to one who has never had experience with such prospecting, but an experienced observer will obtain results that are as accurate as any of the factors that enter into an estimate of brown-ore tonnage.

The value of a detailed topographic map in connection with the prospecting of brown ore, as well as in later development work, can not be overestimated. On such a map may be plotted the positions of all test wells or drill holes, and the productive areas may be shaded or colored. The contours will show the relative altitude of the top of each prospect, so that profile sections can easily be drawn to show the vertical range of the ores and their relation to the drainage. By means of such a map it is much easier to select the best sites for a storage dam, pump house, washers, and settling pond, and to lay out mine openings, railway and tram tracks, pipe lines, etc. A convenient scale for such a map is 100 feet to 1 inch, with 5 to 10 foot contour intervals. A large supply of water is essential to brown-ore mining, and it is therefore as necessary to make sure of the water supply as of the ore supply in prospecting.

## PROSPECTING BY MAGNETIC SURVEYS AND DRILLS.

### LAKE SUPERIOR ORES.

#### EXPLORATION BY MAGNETIC SURVEY.

The Lake Superior iron ores are (1) soft brown or red slaty hydrated hematites; (2) soft limonite; (3) hard massive and specular hematites; (4) magnetite; and (5) various gradations between the other classes. About 93 per cent of the shipments is composed of soft hematite from the Mesabi district, Minnesota, and hard hematite from Ely, Minn., and the Gogebic district, Michigan, and about 7 per cent consists of hard hematite, specular hematite, and magnetite from the Marquette district, Michigan.[1]

The Lake Superior iron ore districts lie within the region of glacial drift. Over certain of the districts, such as the Marquette, the eastern Menominee, the Gogebic, and parts of the Vermilion and the Mesabi, the clay, sand, and gravel deposits, which constitute the major portion of the drift, are relatively thin and the hard rock outcrops are abundant. Over the Crystal Falls, Iron River, and Cuyuna districts the drift is thicker and outcrops are either very few or are entirely wanting. Under such conditions the traverses ordinarily made in constructing a geologic map or in tracing the outcrop of an ore bed are of little service, and methods of surveying dependent on the magnetism of certain of the buried rocks have been developed. The great bulk of the ores are not magnetic to a noticeable degree, but certain of the iron-bearing rocks possess sufficient magnetism to affect the magnetic needle. The iron-ore bodies in the Lake Superior

[1] Van Hise, C. R., and Leith, C. K., The geology of the Lake Superior region: Mon. U. S. Geol. Survey, vol. 52, 1911, pp. 479 et seq.

districts are found in a wide variety of shapes. They may be roughly tabular in a horizontal plane, as in the Mesabi district, or roughly tabular in steeply inclined planes or in steeply pitching linear shoots, as in the Menominee district, or they may occur in almost any combination of these shapes. Structural conditions have mainly determined the location of ores within a given area of the iron formation. Impervious basements for ore bodies are formed in the Gogebic district by the intersection of the footwall quartzite with an igneous dike; in the Marquette district by irregular intrusive masses of basic rock and by slate; in the Menominee district by dolomite; in the Crystal Falls, Iron River, and Florence districts by slate; in the Gogebic and Mesabi districts by interbedded slate layers, and locally in the Mesabi district by granite. Most of the impervious basements in which the ores have been localized are in the form of pitching troughs. The ores are also found in fractured zones in the iron-bearing formation and in the neighborhood of faults that have intersected the impervious basement, both of these structures being favorable to the passage of altering solutions.

Van Hise[1] and his associates give the following discussion with regard to the magnetism of the Lake Superior iron ores and iron-bearing formation:

*Magnetism of the Lake Superior iron ores and iron-bearing formations.*—All ores of iron are found to be magnetic when tested by sufficiently delicate means. Ordinarily magnetite is the only iron mineral which causes conspicuous disturbance of the magnetic needle. Practically all the Lake Superior iron-bearing formations contain at least minute quantities of magnetite, and hence all exert an influence on the magnetic needle, but in widely varying degree. The iron-bearing formation of the Vermilion district and other Keewatin areas is strongly magnetic. The same is true of the formation in the east end of the Mesabi district, the Gunflint district, the Cuyuna district, and the east and west ends of the Gogebic district, and of most of the Negaunee formation of the Marquette district. Less magnetic parts of the iron-bearing formations are those producing principally hematite and limonite, as the central and western parts of the Mesabi, the central part of the Gogebic, and parts of the Menominee and Crystal Falls districts. The iron-bearing member of the Iron River district of Michigan affects the magnetic needle only locally and slightly.

Every known iron-bearing formation in the Lake Superior region, with the exception of that in the extreme west end of the Mesabi district, has been outlined partly as a result of magnetic surveys. In some of the districts, as, for instance, the Iron River district, the magnetic variation is slight, but careful observations will detect it. In addition, several magnetic belts are known in which exploration has not yet shown the character of the iron-bearing formation. * * *

Strong magnetic disturbance does not necessarily mean ore, and, vice versa, ore does not necessarily cause strong magnetic disturbance. Lean amphibolitic schists may be highly magnetic, while rich hydrated soft ore has but little effect on the needle. Although magnetic disturbance is usually caused by an iron-bearing formation, it is also caused by certain basic igneous rocks, like the ellipsoidal basalts of the Keewatin or gabbro intrusives. There is little difficulty in ascertaining the cause of the attractions, however, for somewhere along most of the magnetic belts in the Lake Superior region there are outcrops which indicate the nature of the rock causing the disturbance. If the rock is entirely covered, it may still be possible to determine whether the disturbance means iron-bearing formation or some other rocks. The iron-bearing formations are sedimentary deposits with certain linear characteristics of distribution, giving even lines or "belts" of magnetic attraction, whereas the basic igneous rocks are likely to cause a much more irregular magnetic field. * * *

Although the iron ores may not be discriminated by means of the magnetic disturbances, it is possible under some conditions to draw useful inferences from them as to the dip or folding of a buried iron-bearing formation. A sharp, narrow belt of magnetic attraction leading up to a definite maximum usually means a highly tilted formation presenting a narrow erosion edge at the rock surface, as in the Gogebic or

[1] Van Hise, C. R., and Leith, C. K., op. cit., pp. 486–488.

the Vermilion district. A wide, more irregular, and less well-defined belt of attraction is ordinarily associated with a flatter dip, exposing a greater area of iron-bearing formation to the erosion surface. The producing part of the iron-bearing Biwabik formation of the Mesabi district illustrates this. Unequal magnetic gradient on two sides of a maximum may indicate the direction of dip of the iron-bearing beds. The outward dip of the iron-bearing formation about the Archean ovals of the Crystal Falls district is so indicated. Several roughly parallel, more or less discontinuous magnetic belts, here and there converging and joining, may indicate repeated pitching folds, as in the Cuyuna district.

General laws of interpretation of magnetic attraction require much local modification. It is usually necessary to ascertain for each locality the magnetic character of the iron-bearing formation, to correlate this with known facts from outcrops or underground workings, and from the knowledge thus obtained to interpret the results of the magnetic formations in covered parts of the area where the magnetic readings alone are available. H. L. Smyth,[1] in connection with much magnetic field work in the Lake Superior region, has developed mathematical relations between magnetic fields and various attitudes of the rock beds which may serve as a useful guide in detailed surveys.

The instruments which have been used in Lake Superior magnetic surveys are the dip needle and the dial compass. The dip needle determines the vertical component of the magnetic pull, as well as the direction of the horizontal pull; the dial compass determines only the direction of the horizontal pull. Methods of using and interpreting these instruments are discussed in detail by Smyth. The dial compass is essential in most of the work because it affords means of keeping accurate directions necessary for location and of reading the horizontal component of the magnetic variation. It may be used only on sunny days, and thus magnetic work in the Lake Superior region is likely to be slow and expensive. The dip needle may be used at any time, but in a disturbed field it affords no means of keeping horizontal directions, and hence location. This is an essential defect in country in which the roads and other works of man afford little aid in keeping location.

In theory the use of the magnetic needle is simple, but much practice is required to insure uniformly accurate observations. The unskilled observer finds many pitfalls in the mechanism of the instrument, in the manner of holding it, in the effects of temperature, in electrification from rubbing the glass, etc. There is much opportunity for the exercise of good judgment in the determination of the intervals at which readings shall be taken, the direction and number of runs, etc. These should be varied for different areas, depending on the structure found or suspected. Finally, the interpretation of the results calls for consideration and careful balancing of a great variety of factors, capacity for which is acquired only by wide experience and painstaking observation. * * *

A very interesting and practical discussion of exploration and prospecting for iron ore and of the magnetism of rocks and the use of the needle in exploration was published by Maj. T. B. Brooks[2] in 1873 and is still a standard for reference. The discussion of prospecting covers such points as: Prospecting and woodcraft; organization of party; supplies; equipment; maps; mode of working; how to recognize iron ore; digging for ore; sinking, drifting, trenching, drilling; quality and quantity of ore; average sample and how to get it; approximate analyses in the woods. The discussion of magnetism touches among other things on magnetism of rocks and use of the needle; elementary principles of magnetism; magnetic instruments; dip compass and its use; solar compass; Ritchie's compass; Amsden's compass; geologic sketch of the magnetic rocks; loadstones; magnetic rocks are not ores; origin of ores; explanation of magnetic chart, plans, and sections; practical suggestions and rules; what can and what can not be determined by the needle.

A practical discussion of the methods of magnetic surveying with sundial and dip needle as used for prospecting deep-seated iron ore

[1] Smyth, H. L., Magnetic observations in geological mapping: Mon. U. S. Geol. Survey, vol. 36, 1899, pp. 336–373.

[2] Geol. Survey Michigan, vol. 1, 1873, pp. 187–244.

deposits in the Lake Superior region was published about one year ago by Archibald,[1] from which the following extracts are quoted:

*Instruments for magnetic surveying.*—The usual instruments used in this region for magnetic work are the sundial compass and the dip needle. These instruments are both of prime importance, although much of the work has been done with the dip needle alone.

The sundial compass is an instrument that was invented by Burt for land surveying in districts of magnetic attraction. The common type consists of a 3-inch magnetic needle mounted in a circular box around the upper outside edge of which is placed the hour circle graduated for the latitude in which the observations are to be taken. Different gradations are furnished by the maker for each one-half degree variation in latitude. In the line of the meridian, or in the positions of noon and 6 p. m., are mounted vertical sight standards. A silk or linen thread is attached to the standard placed in the position of noon and is stretched across the dial in the plane of the meridian. This string, called the gnomon, makes an angle with the horizontal equal to the latitude. The standard should have different points for attachment so that the inclination of the string can be varied to agree within a half degree with the latitude of the place where the observations are made. The usual method of doing this is by having holes punched at different heights on the standards marked with the corresponding latitudes. A more desirable form would be a vertical standard with a variable adjustment which could be made to slide up and down the standard by means of an adjusting screw and which would carry the hole through which the thread could be made fast. The instrument as a rule is provided with level bubbles and is made to set up on a single vertical stick or Jacob's staff.

The method of operating the sundial is as follows: When the instrument is set up with the standards in a north-south plane, the shadow cast by the gnomon on the dial will indicate the correct apparent solar time. Therefore, in order to obtain a true north line it is only necessary to orientate the instrument so that the shadow indicates this time. In order to get correct apparent solar time from standard time two corrections are necessary; to subtract or add the difference in time corresponding to the number of degrees west or east of the standard meridian at which the observation is taken. This will give mean solar time, to which time must be added or subtracted a correction, the equation of time from solar ephemeris for the day, month, and year of the observation. Example: Longitude of place of observation equals 88½ degrees; date of observation, November 1, 1908; standard 90th meridian time, 12 noon; one hour in time equals 15 degrees; 90−88½ is equal to 1½ degrees; 1½ degrees of longitude equals 6 minutes time; therefore, mean solar time equals 12.06 p. m.; equation of time to be added for November 1, 1908, taken from solar ephemeris, equals 16 minutes, 19 seconds; therefore, apparent solar time is equal to 12 hours, 22 minutes, 19 seconds; therefore, if the shadow of the gnomon is placed at 22 minutes and 19 seconds past 12 the sight standards will be in a true north-south plane.

The errors to which observations with this instrument are liable are due, first, to the use of an instrument whose hour circle is not graduated for the latitude of the place of observation; second, errors due to poor watches and incorrect calculations of time; and third, errors due to the fact that the gnomon is not adjusted on the instrument to the angle of the latitude.

In regard to the second error it is suggested that when a new camp is pitched and the watches are correct it is well to set up the instrument and place two stakes accurately on the north-south line, then each morning before taking the instrument into the field the watches can be set by orientating the instrument on the stakes and observing the shadow on the dial. This gives a handy method of correcting the watches each day and insures accurate time.

The third error is a much more serious one. It is due to imperfections in the manufacture of the instrument. The vertical standards are made so that they fold when packed. The hinges on these standards are so imperfect that it is difficult to be sure that the standard to which the gnomon is attached is truly vertical when raised. In case it is not, the angle that the string makes with the horizontal will not be equal to the angle of the latitude and a serious error will be introduced. To overcome this error the observer should make a triangle of cardboard with one angle equal to the latitude. The angle of the gnomon can then be tested at any time in the field with this triangle. In case the instrument were made with a screw adjustment this error could be corrected at any time.

*Surveying with the sundial compass.*—In making the observations with a sundial compass it is customary to run north-south or east-west lines from the Government subdi-

[1] Archibald, R. S., Magnetic surveys of iron deposits; Eng. and Min. Jour., June 10, 1911, pp. 1157–1160.

vision points. These lines are run as close together as the character of the work justifies. The usual practice is to run them not more than one-eighth of a mile apart, that is, one between every sixteenth post. The normal magnetic variation is set off on the instrument by means of a vernier provided on the compass. At regular intervals, say at 100 paces or less on these north-south or east-west lines, the instrument is set up and orientated and the magnetic variation is recorded. In connection with the reading of the horizontal needle at these stations, dip-needle readings are taken, as will be explained later. It is also customary to make a detailed geologic study of the country passed over at the same time, outcrops being located with reference to the line run with the compass. When in a magnetic country the strike of the rocks should be taken by means of the sundial also. Trained woodsmen are employed to run the compass and the limit of error of 1 in 100 or 20 paces to the mile is common in this class of work.

The dip needle is an instrument used to observe the vertical component of a magnetic field. There are two types in general use: The Norwegian needle, in which the magnet is pivoted on a universal joint so that it assumes the direction of the magnetic field; and the other type in which it is fixed rigidly in one plane, which permits of only a vertical deflection. The fixed-needle instrument is found to work much more satisfactorily than the Norwegian needle, because it is more sensitive and the bearings do not get out of order so quickly. In using, the observer must orientate it into the plane of the horizontal needle at the station of observation. The needle of the dip needle is weighted on the south end with a piece of wire to overcome the moment of the normal magnetic field. This wire can be adjusted so that the needle will read zero in a region of no local attraction. However, it is difficult to keep the needle at this adjustment so that it is more practical to record a constant error. In the rough field work incident to magnetic observations the bearings of the dip needle are apt to be injured. Constant care and attention are necessary to insure accurate reading with this instrument. It is good practice to have two or more needles in the same party. Frequent comparisons of readings over the same station will indicate whether they are working accurately. The writer has had occasion to use as many as three different needles during the same season's field work. The novice with this instrument is very apt to get a set of observations of absolutely no value.

*Recording magnetic work.*—The easiest method of mapping and recording magnetic work is on square cross-section paper 20 inches wide ruled with 10 divisions per inch. The work is usually mapped by sections and the outcrop plotted on the same map. A convenient scale with the cross-section paper is 20 inches, equal to 1 mile. In the field the trained woodsman is accustomed to pace 20 tallies, or 2,000 paces, to the mile. In case his natural stride does not agree with this length of pace he corrects it at the end of each tally. On the above scale 1 tally is equal to 1 inch, and one small division on the paper, or one-tenth inch, equals 10 paces.

The readings of the horizontal needle are entered on the map at the stations where they are observed, with an arrow indicating whether they are east or west of north. The dip-needle readings are plotted in the form of a curve from the north-south or east-west line of that traversed as a base and each degree of dip is plotted equal to one small division of the cross-section paper. When completed the map is in such shape as to permit making deductions as to location and structure of magnetic rocks as well as geological inferences from outcrops. In working with these maps a special scale can be purchased divided with 1 inch equal to 264 feet, so that distances can be scaled directly from the map.

In the field a convenient notebook is the engineer's cross-section notebook, 6½ by 8½ inches in size, with rulings of cross-section paper the same as has been described. Each page of the book is large enough to cover five large squares each way, and therefore will include a 40-acre tract with sufficient room at the bottom of the page for geological notes and specimen numbers. A convenient arrangement of the notes is to use the first two pages on the right and left hand sides of the open book as the northeast quarter of the northeast quarter and the northwest quarter of the northwest quarter, respectively. The next two pages, the southeast quarter of the northeast quarter and the southwest quarter of the northeast quarter, and so on through the other quarters of the section. This is a simple and logical arrangement of the notebook.

*Interpretations of magnetic readings.*—It is not the purpose of this paper to go into a mathematical discussion of the theory of the effects of the magnetic disturbance upon a horizontal and a vertical needle. However, an attempt will be made to give a practical discussion of the phenomena and rules to guide in the proper interpretation of them. This discussion is condensed from Monograph 36[1] of the United States Geological Survey on the Crystal Falls iron-bearing district.

[1] Smyth, H. L., op. cit.

As has been indicated, the formations to be explored are either sedimentary or a more or less regular contact of sediments with intrusives. This results in the localization of the magnetism in the form of long narrow bands more or less steeply inclined.

The magnetism in these bands is due to induction by the earth's field. Therefore, negative or south pole polarity is uniformly found at the outcrop, while the north pole, considering the rocks as magnets, is located at an indefinite distance below the surface out of reach of influence upon the compass or dip needle. A magnetic formation can, therefore, be considered as a solid sheet magnet with the south pole uppermost. In magnetic work the lines are run north and south or east and west, whichever direction cuts the formation at the greatest angle.

The vertical and horizontal components of the magnetism in rock strata combined with the vertical and horizontal components of the earth's magnetic field determine the resultant forces acting on the vertical and horizontal needles. The earth's magnetism is approximately constant.

The magnetic force of a given magnetic band varies inversely with the square of the distance of the instrument from the seat of the magnetism in the band. In general, this force is dependent upon the thickness of the overburden and the distance of the instrument from the formation.

In discussing the phenomena observed in the readings of the horizontal and vertical needles, the following cases will be discussed: (1) Magnetic formation with vertical dip; (2) magnetic formation dipping at any angle and with strike inclined at any angle to the north; (3) the special case of the magnetic rocks striking due east; (4) parallel magnetic formations.

*Zones of magnetism at contacts.*—Any method of tracing the surface contours of the footwall or, in fact, any contour of any sedimentary bed intimately associated with the ore, will be of great importance in locating structural troughs where the ore is likely to be found. In the case of deposits formed by the intersection of intrusives, any method that will locate the exact position of the contact between the iron ore and the intrusive will be of use in determining where to drill for these ore bodies.

* * *

The majority of the ore bodies themselves and also the inclosing rocks unaltered by the effects of metamorphism by igneous intrusion are nonmagnetic, but fortunately for the magnetic prospector it often happens, especially in the Crystal Falls, Iron River, and Cuyuna districts that there is found magnetic slate intimately associated with the ore. The tracing of the location and strike of this slate gives an indication of the situation of the ore and also of structural troughs. In the case of ore bodies formed by intersecting dikes it has been found in many instances that the contact of the dikes and iron formation was magnetic. Thus it is possible by magnetic means to map these contacts.

*Vertical magnetic formation.*—Let us consider under this head a magnetic formation with a vertical dip, a width of $2A$, and a depth to cover equal to $H$. In approaching such a formation from the east, on an east-west traverse, the horizontal needle will first show a westward deflection, increasing with the approach to the formation and reaching a maximum near the east edge of the belt. It will then begin to decrease and reach zero in the center of the belt, increasing with an eastward deflection to an east maximum near the west edge of the formation and thence decreasing to normal, outside of the reach of the magnetic formation. If $X$ represents the distance of the maximum points from the center of the formation, it can be shown that: $X^2=H^2+A^2$. The relative amount of deflection at the east and west maxima will depend upon the direction of the strike of the rocks. When the strike is north these two maxima will be equal. When it strikes east of north the western maximum is the greater. When striking west of north the reverse is the case.

With an east-west traverse approaching the formation from the east the vertical needle will start with a constant error outside of the range of magnetic influence of the rock and increase gradually through a maximum at a point within the formation; passing westward it will again decrease to zero. The point of maximum deflection in a formation with a north strike will be in the center. With a formation the strike of which is inclined at an angle to the north, the maximum deflection will be reached at a point that lies on the side of the formation making an obtuse angle with the east-west traverse.

As in the case of the horizontal needle, it is also found with the dip needle that the dip curve, or curve representing the respective readings of the dip needle, will not be symmetrical in approaching a formation with other than a north strike. When the formation strikes east of north, the western dips are greater or the dip curve will be steeper on the east side, or, generally speaking, stations on the side of the formation

on which the east-west line of traverse make an obtuse angle show the greater dips. These conclusions are only true for vertical formations.

*Magnetic formation of any dip.*—In formations dipping at moderate to low angles the assumption that the north pole of magnetism is out of reach of the needles is not warranted. The influence of the bottom pole is to decrease the force acting upon the needle at any point. The following general conclusions can be demonstrated mathematically and have been observed in the field with regard to behavior of the vertical and horizontal needles under these conditions of dip of formation: (1) The direction of dip of the magnetic formation is toward the nearer of the two maxima to the point of zero horizontal deflection. (2) The point of no deflection of the horizontal needle is not over the center of formation but lies nearer the dip side. (3) In rocks with slight dips the horizontal maxima are not so pronounced, and irregularities in the behavior of the needle are observed. (4) The dip needle shows a maximum value near the zero of the horizontal needle only where the rocks are steeply inclined. In case of flat dipping rocks the vertical needle is apt to show, on the side opposite the dip side, a wide zone of readings which are less than normal.

*Magnetic rocks striking due east.*—The prevailing strike of a large number of iron-bearing rocks of the Lake Superior region is east, so that the special case of the behavior of the vertical and the horizontal needle with such rocks is of importance.

In prospecting such a formation the traverse should be run north and south. In approaching the belt from the south it will be readily seen that the horizontal needle will give but little indication of its presence, inasmuch as the magnetism of the rocks acts in the same direction as that of the earth; therefore no southern maximum will be observed. After passing the magnetic belt the magnetism of the earth and the magnetism of the rocks will act in opposite direction, and when that of the rocks exceeds that of the earth the direction of the needle will be completely reversed, and the north end will point south. Farther north the earth's magnetism will counterbalance the local magnetism and the needle will again swing around into the meridian. It generally happens, however, especially when the rocks are not overlain by deep cover of drift, that the irregular distribution of the magnetism on their surface will produce other deflections than those described. They will be haphazard and will not indicate magnetic maxima.

The dip needle readings for an east striking formation with a considerable covering of drift is as follows: Starting with a reading of constant error at a considerable distance from the formation, in moving northward the readings increase slowly to a point north of the center of the formation, where they reach a maximum. Then they decrease until they reach a normal condition north of the influence of the magnetism of the rocks. The reading north of the maximum will uniformly show higher value than corresponding points to the south; that is, the dip curve has a steeper slope south of the maximum than north. It often happens that readings less than normal will be observed south of the magnetic belt. This is due to the fact that the rocks have a very small covering and the horizontal magnetic forces are so strong that they counteract the vertical component.

*Parallel magnetic formations.*—In the previous discussion only one belt of magnetism has been considered. It often happens that two belts of magnetic formation lie so close together that their magnetism combines to produce a different set of phenomena. This is the case where there are two distinct magnetic formations in the same series of rocks.

It more often happens that the same magnetic belt has been repeated by close folding or faulting or by intrusion of a narrow eruptive producing the phenomena of parallel formations. The proper interpretation of the phenomena is of importance in working out the structure of the rock and especially in the detection of synclinal folds where the presence of ore bodies is probable. Under this heading will be discussed, first, formations parallel and with a vertical dip; second, parallel formations dipping at equal angles in the same direction; third, parallel formations dipping toward each other, and, fourth, parallel formations dipping away from each other.

In formations with a vertical dip, or in fact with any parallel formations, the phenomena vary widely with the distance between the magnetic formations and with the depth of surface covering. In general it can be said that formations with a vertical dip will show three points of minimum horizontal readings with three corresponding maxima. One of the horizontal minima will be midway between two formations and the other will be at the outer edges of the magnetic belts. As the depth of cover increases the minima and maxima will grow less distinct and finally merge into one point of minimum deflection midway between the two formations and two maxima at the outer edges of the two belts. The vertical needle will show two points of maximum deflection opposite the center of each magnetic formation.

*Formations dipping in the same and opposite directions.*—In the case of formations both dipping in the same direction at the same angle, the horizontal needle will usually show three minima, one between the formation and the other two on the dip side of each belt. The vertical needle as a rule will show two maximum points of deflection, one on the dip side of each formation.

When the formations dip toward each other there is an infinite variety of phenomena, depending on the relative dips of each formation and the depth of cover. There will usually be indications of horizontal minimum values at three places with corresponding maxima. One of the minima will be between the two formations, the other two being on the dip side of each formation. The side of the two outside maxima indicate the steepness of the dips of the respective formation, the formation with the steeper angle of dip having the larger maximum. In the same way the vertical needle shows two maximum values, one over each formation, the greater maximum over the steeper. It will be readily seen that the above condition of dips of formation will arise from the structure of the syncline.

In the case of two formations dipping in opposite directions which will arise in the structure of an anticline, the distance apart of the two formations, i. e., how deeply the anticline has been truncated, is the determining factor in the character of the readings. When the legs are separated by considerable erosion the phenomena indicate two formations and their respective dips.

There is a central horizontal minimum between the formations and two minima on the dip side of each limb. The dip curve shows two maxima, one on the dip side of each formation. In case the formation has been but slightly eroded, i. e., the legs are close together, the phenomena will indicate one vertical magnetic belt.

*The pitch of anticlinal and synclinal axes.*—It is universally true, in the iron-bearing rocks of this district, that the axes of synclines and anticlines do not continue horizontally for any length of time, but pitch at more or less steeply-inclined angles. It is, therefore, found that the magnetic phenomena of parallel belts will not continue long in the direction of the strike in such a fold. In working toward the outcrop of the axis of the syncline the belts will come closer and closer together until finally the end of the formation is reached, beyond which magnetic phenomena disappear entirely. In working toward this outcrop it will also be found that the direction of the magnetic force of the rock will no longer act at right angles to the strike, but will be inclined in the direction of the pitch of the axis.

In working toward the pitch of an anticlinal axis the belts approach each other as the formation gets deeper and deeper. Finally they will join and continue as one magnetic belt which will grow weaker until finally the rocks are so deeply covered that their magnetic force will not influence the needles at all.

In the case of a formation split by an intrusive, the shape of the intrusive, i. e., the dips of the sides of the contact, will govern the character of the magnetic action. As we pass along the strike of such a formation we will finally come to a point where the intrusion pinches out. This will usually happen abruptly. The magnetic belt will then continue as one formation.

The above discussion may seem to the average user of sundial and dip needle as merely theoretical and the results described unattainable in practice, due to the many disturbing influences and inaccuracies of the instruments. However, careless work has been the rule with these instruments and the fact that more useful information has not been acquired is due more to this cause than to the inadequacies of the instruments. As has been demonstrated by the United States Geological Survey and by some of the more scientific field parties, which have not only located magnetic contacts but also interpreted structural features by their use, careful work will produce results which are of inestimable value in the economic development of ore deposits which are deeply covered by an overburden of drift.

The foregoing discussions with regard to magnetic surveying have no reference to the prospecting for ore deposits other than hematites, and for this reason the Swedish method of locating iron-ore deposits by the use of the magnetometer, a method peculiarly adapted to the exploration of magnetite ore, have not been described here.

Van Hise[1] says with regard to the Swedish methods of explorations:

Because of the conditions above outlined, it is seldom practicable in the Lake Superior region to draw from magnetic observations inferences with regard to the shapes of iron-ore deposits themselves as distinguished from the rest of the iron-bearing formation, such inferences as have been drawn by magnetic surveys of deposits in eastern

[1] Van Hise, C. R., and Leith, C. K., op. cit., p. 487.

Canada, Sweden, and elsewhere. In these regions the ores consist of magnetite associated with relatively nonmagnetic wall rocks, and the magnetic disturbances are produced by the iron ore itself, not by iron ore and wall rock; hence it is possible to draw satisfactory inferences as to the shape and attitude of the iron-ore deposits. In the Lake Superior region the magnetic attractions are useful in locating iron-bearing formations and thus ultimately the iron ore by underground exploration, but do not directly point out the iron-ore deposits themselves. The highly developed Swedish methods of determining both the intensity and the direction of the magnetic pull are therefore unnecessarily detailed and slow for use in the Lake Superior region, and when attempts have been made to locate ore deposits by them the results have been disappointing.

### EXPLORATION BY DRILL.

Van Hise [1] gives a further discussion with regard to the exploration for iron ore by drill in the Lake Superior region, as follows:

*Exploration for iron ore.*—The location of explorations within the areas of the iron-bearing formations is determined by outcrops, by magnetic lines, by mining, and by general geologic structure. It has been possible to confine most of the exploration to the area of the iron-bearing formations, but in certain districts, notably the Cuyuna, Florence, Crystal Falls, and Iron River districts, the distribution and limits of the iron-bearing formation are so uncertain that much exploratory work has had to be done even to locate the formation. All the facts bearing on the distribution of the iron-bearing formation discussed in this monograph are taken into account by choosing areas for exploration. Some of the larger mining companies employ their own geologists to make special reports on the geology of given areas as a preliminary to underground exploration, and nearly all the explorers make liberal use of all the geologic information available in localizing their work.

As the few ore deposits exposed at the surface were found years ago, explorations are now largely conducted by drilling and sinking test pits and shafts. The large size of the iron-ore deposits makes it possible to find and outline them by drilling to an extent not possible in smaller ore deposits, with the result that the greater number of ore bodies, especially in recent years, are thoroughly explored by drilling before mining begins. It has usually been assumed that if drilling does not locate an ore body it is useless to sink a shaft for this purpose. Mining operations have necessarily disclosed much ore which had not previously been found by drilling, especially in certain districts like the Menominee or the Gogebic, where the structural conditions are such as to make the location of ore by drilling extremely difficult. In the region as a whole, mining operations have almost everywhere disclosed greater reserves of ore than the drilling had indicated.

The great dependence placed on drill work has resulted in enormous expenditure for this purpose. Accurate estimates of the amount of drilling done so far in the region can not be made, but a rough estimate compiled from tentative estimates of engineers of the several districts is as follows:

*Drilling done for iron ore in the Lake Superior region.*

| District. | Number of drill holes. | Average depth of drill holes.[a] |
|---|---|---|
| | | *Feet.* |
| Mesabi | 15,000 | 175 |
| Vermilion | 1,000 | 600 |
| Cuyuna | 1,500 | 250 |
| Marquette | 5,000 | 500 |
| Other Michigan ranges and Wisconsin ranges | 4,000 | 300 |
| Total | 26,500 | ..... |

[a] Estimates probably low.

This totals 7,200,000 feet, or about 1,363 miles of drilling. At an average cost of $3 a foot, which is a low estimate, the total expenditure has been roughly $21,600,000.

It is estimated that at the present time there are 400 drills in operation in the region. In the earlier days of exploration test pits were relied upon to a large extent, espe-

[1] Van Hise, C. R., and Leith, C. K., op. cit., pp. 484–486.

cially in areas where the surface drift is thin and the water level below the rock surface. This method of exploration, however, is unsatisfactory because of the great depth of the drift at many places, the difficulty of handling water, and the difficulty after finding the ledge of penetrating it by this method. In later years the use of test pits has been largely superseded by drilling.

Both diamond and churn drills are in use. Through surface and soft-ore formations the churn drill is used. Much of the Mesabi district may be so explored. The cost of churn drilling has ranged from $1 to $3.50 and averaged about $2.50 a foot, varying from district to district according to accessibility and cost of transportation and other factors. The cost of diamond drilling has ranged from $2.25 to $8 a foot and averages at present about $3.75, but varies from district to district. Test pits are cheap, averaging perhaps $1.25 a foot.

The necessity for the most careful study of the structural geology in drilling is illustrated by the frequent failure of drills to locate ore deposits even after what seemed to be careful drilling and the subsequent discovery of the deposits either by further drilling or by mining operations. Indeed, as one comes to realize the variety and complexity of underground structural conditions, he is likely to become more and more disinclined to submit a negative report on any property, no matter how extensively it has been drilled. This difficulty is illustrated by the ore shoots in the Gogebic and Menominee districts, many of which have been missed by drilling and picked up in mining operations. Many of the ore shoots in the Vulcan member of the upper Huronian slate of Michigan pitch beneath the surface, following the axes of drag folds, and it is easy for drills to pass one side or the other, or, if the drill hole is inclined, to go above or below them. On examination of drilling plats of exploration areas it is easy to see where linear shoots of ore might pass through at places not penetrated by the drilling. In fact, drilling in some of these localities is almost as uncertain as shooting a bird on the wing. There are many ways of missing the ore. As knowledge of structural conditions increases, however, adverse chances diminish, with the result that in certain areas after the local structural problems are solved, it is possible to drill with a high degree of success.

A higher average of success in drilling would unquestionably result if greater care were taken in the interpretation of drill records. The drill runner is often allowed to report the character of the drillings and the samples are not kept, with the result that many valuable inferences that might be drawn from the lithology, the dip and strike of bedding and cleavage, and other features are lost. Not infrequently also failure to plat drill records in such a manner that they may be considered in three dimensions may cause promising chances for ore to be overlooked.

There has been a considerable tendency to generalize the principles of ore occurrence and in exploration to carry such principles from one district to another. As a matter of fact, although some of the basic principles are general for the region, the local variations of structure require the most careful study of each area to prevent mistakes in interpretation. When explorers of the Gogebic district, where the ores lie in regular, impervious, pitching basins, went to the Mesabi district, where the rocks are of the same age, they naturally attempted to use the same methods in exploration. But here the flatter dip of the formation, the shallowness of basins, the effect of overlying slates in ponding waters, and the unusually large influence of joints in localizing the concentration of ore made the finding of ore largely a new problem, which was solved at much expense and trouble. Recognizing the danger of carrying the method of exploration of one district into another, certain explorers have gone to the other extreme and have attempted to disregard all guides derived from the study of the structural geology, with results even more unsatisfactory than if they had used principles developed for other districts.

Much the greater part of the exploration of the region has been conducted without taking the fullest advantage of all geologic knowledge available, but there has been a rapidly increasing tendency to follow geologic structure, and therefore an increasing demand for geologic information, as shown by the cordial support that the mining men have given to the efforts of the United States and State surveys in this region and by their considerable expenditures for private geologic surveys. Certain of the drilling companies doing contract work now have geologists on their staffs to aid in the interpretation of records, notwithstanding the fact that such interpretation is primarily in the hands of their clients. The problems of underground exploration are followed keenly, intelligently, and energetically by a large number of skilled men in the employ of mining companies, with the result that advances are being made with a rapidity which is sometimes almost bewildering. Six months may see the development of new facts requiring changes in the interpretation of the drilling of a district. The statements as to structural conditions presented in another chapter

of this book [Monograph 52] may require some modification by the time the book is given to the public, because of the amount of rapidly accumulating information in the interval between the writing and the printing.

## IRON AND STEEL INDUSTRY OF THE UNITED STATES.[1]

### PRODUCTION AND VALUE OF PIG IRON BY STATES.

The marketed production of pig iron in 1911 amounted to 23,257,288 long tons, valued f. o. b. at the furnaces at $327,234,624, as compared with 26,674,123 long tons, valued at $412,162,486, in 1910, a decrease in quantity of 3,416,835 tons and in value of $84,827,862. The average value per ton in 1911 was $14 07, and in 1910 it was $15 45, a decrease in 1911 of $1.38 per ton. The figures of marketed pig iron given for 1910 and 1911 were collected by the United States Geological Survey. The values of pig iron for 1907, 1908, 1910, and 1911 were reported to the United States Geological Survey by the manufacturers and represent the approximate value f. o. b. at the furnaces, therefore eliminating freight costs, commissions, etc., which are included in the market prices of pig iron as published in the trade journals. The value for 1909 is an estimate made on a basis similar to that used in estimating the values prior to 1907. The total production of pig iron includes the metal produced from foreign as well as domestic ore. The quantity and value of blast-furnace products derived from ore imported from Cuba, Sweden, Spain, Newfoundland, and Labrador, Canada, and other countries, although it constitutes a very small percentage of the total production, is considerable, since the sales of pig iron alone, derived from foreign ore, amounted in 1911 to 953,685 long tons, valued at $14,000,066.

*Quantity and value of pig iron marketed in the United States in 1910 and 1911, by States, in long tons.*

| State. | 1910 | | 1911 | | Decrease in 1911. | | Percentage of decrease in 1911. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Alabama | 1,969,770 | $24,127,616 | 1,617,150 | $17,379,171 | 352,620 | $6,748,445 | 17.90 | 27.97 |
| Illinois | 2,606,335 | 41,465,543 | 2,036,081 | 31,152,927 | 570,254 | 10,312,616 | 21.88 | 24.87 |
| Kentucky | 81,677 | 1,312,288 | 57,982 | 870,542 | 23,695 | 441,746 | 29.01 | 33.66 |
| Michigan | 307,975 | 5,119,074 | 304,654 | 4,672,799 | 3,321 | 446,275 | 1.08 | 8.72 |
| New Jersey | 239,221 | 3,797,656 | (a) | (a) | (a) | (a) | (a) | (a) |
| New York | 1,895,018 | 31,693,623 | 1,537,201 | 23,924,194 | 357,817 | 7,769,429 | 18.88 | 24.51 |
| Ohio | 5,584,279 | 85,385,254 | 5,371,378 | 73,484,592 | 212,901 | 11,900,662 | 3.81 | 13.94 |
| Pennsylvania | 11,014,652 | 174,486,833 | 9,581,109 | 136,328,507 | 1,433,543 | 38,158,326 | 13.01 | 21.87 |
| Tennessee | 400,269 | 5,199,099 | 297,594 | 3,439,644 | 102,675 | 1,759,455 | 25.65 | 33.84 |
| Virginia | 402,625 | 5,576,599 | 308,789 | 3,898,285 | 93,836 | 1,678,314 | 23.31 | 30.10 |
| Wisconsin | 278,232 | 4,386,859 | 245,152 | 3,803,049 | 33,080 | 583,810 | 11.89 | 13.31 |
| Other States[b] | 1,894,070 | 29,612,042 | 1,900,198 | 28,380,914 | [c] 233,093 | [c] 5,028,784 | [c] 10.93 | [c] 15.05 |
| Total | 26,674,123 | 412,162,486 | 23,257,288 | 327,334,624 | 3,416,835 | 84,827,862 | 12.81 | 20.58 |

[a] Included in "Other States."

[b] 1910: California, Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, Washington, and West Virginia; 1911: California, Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia.

[c] Includes decrease in New Jersey.

[1] The statistics for all steel production and certain statistics for pig iron, as noted on succeeding pages, have been collected and published in the annual reports of the American Iron and Steel Association.

The following table gives the annual average price per long ton of pig iron in the United States for the years 1889 to 1911, inclusive. The prices prior to 1907 include the cost of transportation from blast furnaces to markets. The extreme range in prices, from $9.76 in 1894 to $20.92 in 1902, is of interest in view of present manufacturing conditions.

*Average price per long ton of pig iron in the United States, 1889–1911.*

| | | | | | |
|---|---|---|---|---|---|
| 1889 | $15.78 | 1897 | $9.85 | 1905 | $16.63 |
| 1890 | 16.43 | 1898 | 9.90 | 1906 | 19.98 |
| 1891 | 15.50 | 1899 | 18.00 | 1907 | 20.56 |
| 1892 | 14.32 | 1900 | 18.85 | 1908 | 15.96 |
| 1893 | 11.90 | 1901 | 15.25 | 1909 | 16.25 |
| 1894 | 9.76 | 1902 | 20.92 | 1910[1] | 15.45 |
| 1895 | 11.14 | 1903 | 19.12 | 1911[1] | 14.07 |
| 1896 | 10.47 | 1904 | 14.13 | | |

The average price of pig iron per long ton, by States, for 1910 and 1911 is given in the following table. This represents the price at the blast furnaces and does not include the prices of ferro-alloys.

*Average price per long ton of pig iron in the United States, 1910 and 1911, by States.*

| State. | 1910 | 1911 |
|---|---|---|
| Alabama | $12.25 | $10.75 |
| Illinois | 15.91 | 15.30 |
| Kentucky | 16.07 | 15.01 |
| Michigan | 16.62 | 15.34 |
| New Jersey | 15.88 | (*a*) |
| New York | 16.72 | 15.56 |
| Ohio | 15.29 | 13.68 |
| Pennsylvania | 15.84 | 14.23 |
| Tennessee | 12.99 | 11.56 |
| Virginia | 13.85 | 12.62 |
| Wisconsin | 15.77 | 15.51 |
| Other States *b* | 15.63 | 14.94 |
| Total | 15.45 | 14.07 |

*a* Included in "Other States."
*b* 1910: California, Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, Washington, and West Virginia; 1911: California, Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia.

## BLAST FURNACES.

The actual commercial capacity of the blast furnaces of the United States on December 31, 1911, is estimated by Luty[2] at about 33,402,000 tons a year, as compared with about 32,837,000 tons at the close of 1910. These estimates are based on the actual production of the country from July 1, 1906, to July 1, 1907, a period in which demand was heavy and prices of pig iron were high. The theoretical capacity of abandoned furnaces which are still in a state of physical but not commercial existence is not considered.

Four new blast furnaces, with a total annual capacity of 565,000 tons, were added during 1911, as compared with 13 new furnaces, having a total annual capacity of 1,794,000 tons in 1910.

[1] Prior to 1910, ferroalloys are included with pig iron.
[2] Luty, B. E. V., Iron Trade Review, Jan. 4, 1912, pp. 12–13.

The new furnaces added in 1911 are as follows, the last two, which were practically complete, not having been blown in during that year:

*New blast furnaces in 1911.*

| Date blown in. | Name. | Location. | Size. | Annual capacity. |
|---|---|---|---|---|
| | | | *Feet.* | *Long tons.* |
| June 8 | Haselton No. 4 | Youngstown, Ohio | 85 by 21½ | 150,000 |
| July 17 | Central D | Cleveland, Ohio | | 150,000 |
| | River No. 2 | Cleveland, Ohio | 83 by 20½ | 125,000 |
| | Josephine No. 2 | Josephine, Pa | 85 by 20 | 140,000 |

On the basis, then, that the working blast furnace capacity during 1911 was increased by 150,000 tons (the capacity of the two new active furnaces for the half year during which they were in operation), which made a total of 32,987,000 tons, the production of pig iron and other blast-furnace products in 1911, amounting to 23,545,551 tons, approximated 71 per cent of the working capacity of blast furnaces in the United States.

The following table shows the number of blast furnaces in blast on June 30 and December 31, and the total number of stacks recorded for the years 1910 and 1911, but does not of course include the electric reduction furnace at Heroult, Cal.:

*Record of blast furnaces in the United States, 1910 and 1911, by States.*[a]

| State. | Furnaces in blast June 30, 1910. | Dec. 31, 1910. | | | Furnaces in blast June 30, 1911. | Dec. 31, 1911. | | |
|---|---|---|---|---|---|---|---|---|
| | | In. | Out. | Total. | | In. | Out. | Total. |
| Pennsylvania | 116 | 74 | 91 | 165 | 81 | 91 | 73 | 164 |
| Ohio | 50 | 35 | 41 | 76 | 35 | 44 | 31 | 75 |
| Illinois | 20 | 11 | 15 | 26 | 16 | 14 | 10 | 24 |
| Alabama | 24 | 20 | 30 | 50 | 17 | 22 | 27 | 49 |
| New York | 18 | 15 | 14 | 29 | 15 | 13 | 16 | 29 |
| Virginia | 11 | 9 | 17 | 26 | 7 | 7 | 18 | 25 |
| Tennessee | 12 | 10 | 10 | 20 | 9 | 8 | 11 | 19 |
| Colorado | 4 | 2 | 4 | 6 | 3 | 3 | 3 | 6 |
| Missouri | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 2 |
| Oregon | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| Washington | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| California | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maryland | 4 | 2 | 3 | 5 | 3 | 2 | 3 | 5 |
| New Jersey | 3 | 2 | 7 | 9 | 1 | 0 | 8 | 8 |
| Wisconsin | 4 | 4 | 3 | 7 | 2 | 4 | 3 | 7 |
| Minnesota | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| Indiana | 6 | 3 | 6 | 9 | 6 | 7 | 2 | 9 |
| Michigan | 11 | 9 | 7 | 16 | 7 | 8 | 8 | 16 |
| West Virginia | 1 | 1 | 3 | 4 | 3 | 3 | 1 | 4 |
| Kentucky | 3 | 2 | 6 | 8 | 3 | 2 | 6 | 8 |
| Georgia | 0 | 1 | 3 | 4 | 0 | 0 | 4 | 4 |
| Texas | 0 | 0 | 4 | 4 | 0 | 0 | 4 | 4 |
| Connecticut | 2 | 3 | 0 | 3 | 0 | 1 | 2 | 3 |
| Massachusetts | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 |
| Total | 293 | 206 | 268 | 474 | 212 | 231 | 235 | 466 |

[a] Statistics of the American Iron and Steel Association.

## MONTHLY PRODUCTION OF PIG IRON.

The accompanying diagram (fig. 3) illustrates the course of the manufacture of pig iron by months during the last five years. The sudden decline in production of pig iron at the close of October, 1907,

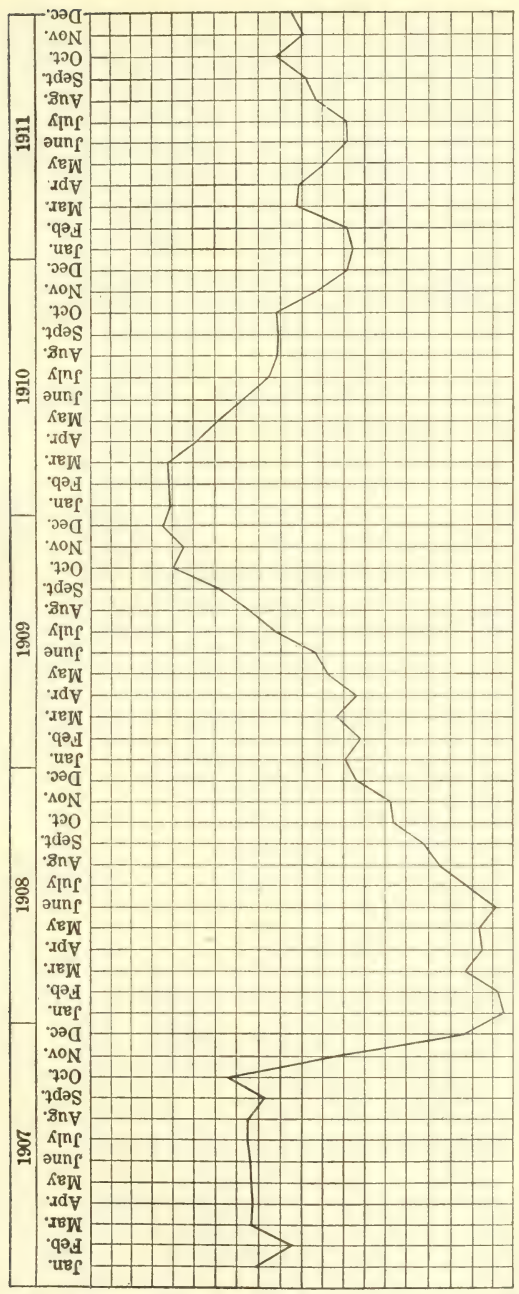



FIGURE 3.—Curve showing production of coke and anthracite pig iron in the United States in 1907, 1908, 1909, 1910, and 1911, by months. Tonnage according to the Iron Age, Nov. 9, 1911, and Mar. 7, 1912.

the low production during the first half of 1908, the slow recovery of activity in the last half of 1908, the hesitating conditions early in 1909, the steady and rapid increase in production during the last part of that year, culminating in December with a record production of more than 2,682,000 tons, the gradual, almost uninterrupted, decline throughout the year 1910, and the moderate production during 1911, broken by alternating declines and recoveries, are graphically indicated.

## PRODUCTION OF PIG IRON BY GRADES.

The following table shows the production of the principal grades of pig iron, from 1907 to 1911, inclusive, according to the statistics of the American Iron and Steel Association:

*Production of pig iron in the United States, 1907–1911, by grades, in long tons.*

| Grade. | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|
| Bessemer and low phosphorus | 13,231,620 | 7,216,976 | 10,557,370 | 11,245,642 | 9,409,303 |
| Basic (mineral fuel) | 5,375,219 | 4,010,144 | 8,250,225 | 9,084,608 | 8,520,020 |
| Forge pig iron | 683,167 | 457,164 | 725,624 | 564,157 | 408,841 |
| Foundry and ferrosilicon | 5,151,209 | 3,637,622 | 5,322,415 | 5,260,447 | 4,468,940 |
| Malleable Bessemer | 920,290 | 414,957 | 658,048 | 843,123 | 612,533 |
| Spiegeleisen | 283,430 | 111,376 | 142,831 | 153,055 | 110,236 |
| Ferromanganese | 55,918 | 40,642 | 82,209 | 71,376 | 74,482 |
| White, mottled, direct castings, etc | 80,508 | 47,137 | 56,749 | 81,159 | 45,192 |
| Total | 25,781,361 | 15,936,018 | 25,795,471 | 27,303,567 | 23,649,547 |

## PRODUCTION OF PIG IRON ACCORDING TO FUEL USED.

In the following table are given the statistics of the American Iron and Steel Association showing the production of pig iron according to the fuel used, from 1907 to 1911, inclusive:

*Production of pig iron according to fuel used, 1907–1911, in long tons.*

| Fuel used. | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|
| Bituminous, chiefly coke | 23,972,410 | 15,331,863 | 24,721,037 | 26,257,978 | 23,141,296 |
| Anthracite and coke | 1,335,286 | 353,315 | 682,383 | 628,579 | 212,548 |
| Anthracite alone | 36,268 | 1,694 | 16,048 | 20,503 | 17,027 |
| Charcoal | 437,397 | 249,146 | 376,003 | 396,507 | 278,676 |
| Total | 25,781,361 | 15,936,018 | 25,795,471 | 27,303,567 | 23,649,547 |

## TOTAL PRODUCTION OF PIG IRON.

The following table shows the production of pig iron in the United States as far as has been recorded. The statistics for years from 1854 to 1911 were collected by the American Iron and Steel Association and include the production of the commoner ferro-alloys; those for 1810, 1840, and 1850 are census figures; those for the other years are largely estimates by early statisticians.

*Production of pig iron in the United States, 1810–1911, in long tons.*

| Year. | Quantity. | Year. | Quantity. | Year. | Quantity. |
|---|---|---|---|---|---|
| 1810 | 53,908 | 1864 | 1,014,282 | 1889 | 7,603,642 |
| 1820 | 20,000 | 1865 | 831,770 | 1890 | 9,202,703 |
| 1828 | 130,000 | 1866 | 1,205,663 | 1891 | 8,279,870 |
| 1829 | 142,000 | 1867 | 1,305,023 | 1892 | 9,157,000 |
| 1830 | 165,000 | 1868 | 1,431,250 | 1893 | 7,124,502 |
| 1831 | 191,000 | 1869 | 1,711,287 | 1894 | 6,657,388 |
| 1832 | 200,000 | 1870 | 1,665,179 | 1895 | 9,446,308 |
| 1840 | 286,903 | 1871 | 1,706,793 | 1896 | 8,623,127 |
| 1842 | 215,000 | 1872 | 2,548,713 | 1897 | 9,652,680 |
| 1846 | 765,000 | 1873 | 2,560,963 | 1898 | 11,773,934 |
| 1847 | 800,000 | 1874 | 2,401,262 | 1899 | 13,620,703 |
| 1848 | 800,000 | 1875 | 2,023,733 | 1900 | 13,789,242 |
| 1849 | 650,000 | 1876 | 1,868,961 | 1901 | 15,878,354 |
| 1850 | 563,755 | 1877 | 2,066,594 | 1902 | 17,821,307 |
| 1852 | 500,000 | 1878 | 2,301,215 | 1903 | 18,009,252 |
| 1854 | 657,337 | 1879 | 2,741,853 | 1904 | 16,497,033 |
| 1855 | 700,159 | 1880 | 3,835,191 | 1905 | 22,992,380 |
| 1856 | 788,515 | 1881 | 4,144,254 | 1906 | 25,307,191 |
| 1857 | 712,640 | 1882 | 4,623,323 | 1907 | 25,781,361 |
| 1858 | 629,548 | 1883 | 4,595,510 | 1908 | 15,936,018 |
| 1859 | 750,560 | 1884 | 4,097,868 | 1909 | 25,795,471 |
| 1860 | 821,223 | 1885 | 4,044,526 | 1910 | 27,303,567 |
| 1861 | 653,164 | 1886 | 5,683,329 | 1911 | 23,649,547 |
| 1862 | 703,270 | 1887 | 6,417,148 | | |
| 1863 | 846,075 | 1888 | 6,489,738 | | |

## PRICES OF PIG IRON.

In the following table are given the average monthly prices of the principal kinds of pig iron for 1910 and 1911:

*Average monthly prices per ton of pig iron, 1910 and 1911, by months and kinds.*

| Month. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | No. 2 foundry pig iron at Pittsburgh.[a] | Gray forge pig iron at Pittsburgh.[b] | Bessemer pig iron at Pittsburgh.[b] | Basic pig iron at Philadelphia.[c] | No. 2 foundry pig iron at Pittsburgh.[a] | Gray forge pig iron at Pittsburgh.[b] | Bessemer pig iron at Pittsburgh.[b] | Basic pig iron (eastern Pennsylvania and nearby points).[c] |
| January | $17.94 | $17.15 | $19.90 | $18.75 | $14.75 | $14.09 | $15.90 | $14.25 |
| February | 17.38 | 17.15 | 19.42 | 18.56 | 14.81 | 14.15 | 15.90 | 14.44 |
| March | 17.00 | 16.60 | 18.90 | 18.25 | 14.96 | 14.15 | 15.90 | 15.25 |
| April | 16.75 | 16.35 | 18.15 | 17.56 | 15.00 | 14.15 | 15.90 | 15.19 |
| May | 16.18 | 16.09 | 17.09 | 16.69 | 14.72 | 14.02 | 15.90 | 14.75 |
| June | 15.53 | 15.10 | 16.73 | 16.10 | 14.56 | 13.90 | 15.90 | 14.50 |
| July | 15.40 | 14.52 | 16.40 | 15.68 | 14.53 | 13.90 | 15.90 | 14.38 |
| August | 15.16 | 14.45 | 16.21 | 15.12 | 14.47 | 13.90 | 15.90 | 14.65 |
| September | 14.93 | 14.25 | 15.90 | 15.00 | 14.40 | 13.90 | 15.90 | 14.69 |
| October | 14.88 | 14.15 | 15.90 | 15.00 | 14.34 | 13.84 | 15.39 | 14.50 |
| November | 14.78 | 14.09 | 15.90 | 14.75 | 14.25 | 13.60 | 15.10 | 14.50 |
| December | 14.65 | 13.90 | 15.90 | 14.75 | 13.90 | 13.46 | 15.15 | 14.25 |

[a] Eng. and Min. Journ., Jan. 13, 1912.
[b] Iron Trade Review, Jan. 5, 1911, and Jan. 4, 1912
[c] Iron Age, Jan. 5, 1911, and Jan. 4, 1912.

## FERRO-ALLOYS.

### PRODUCTION.

The United States Geological Survey has undertaken for the first time to present the statistics of production of ferro-alloys separately from those of pig iron, with which they have been heretofore included.

Although the quantity of ferro-alloys is small, amounting to only about one-eighth of the average production of pig iron for one month or to about 1.24 per cent of the total production of pig iron during the year, the value per ton is so much greater as to have an important influence on the apparent value of the pig iron if included with it; therefore it has been decided to separate the two subjects. There is a sufficient number of producers of the commoner ferro-alloys, such as ferromanganese, spiegeleisen, ferrosilicon, and ferrophosphorus to give the production of these two groups of alloys separately; but the production of the rarer alloys, such as ferromolybdenum, ferrotitanium, ferrotungsten, and ferrovanadium, must be grouped together. It should also be stated that the values of the first two groups of ferro-alloys have been in part estimated by the Survey.

The total marketed production of ferro-alloys in 1911 as reported to the United States Geological Survey was 253,375 long tons, valued at $8,377,832. Of this production 91,612 long tons, valued at $4,084,836, were made from imported ores. The ferrovanadium, ferromolybdenum, ferromanganese, and spiegeleisen contributed largely to the total alloys containing imported ore. The total quantity reported does not represent the total production of the United States, since the production of considerable quantities of electrically produced ferro-alloys was not reported to the Survey.

The sales of ferromanganese and spiegeleisen amounted to 178,615 long tons, valued at $4,746,541, and of ferrosilicon and ferrophosphorus to 70,122 long tons, valued at $1,345,884. This represented a decided decrease in both quantity and value for the first group, whose production amounted to 226,216 long tons, valued at $6,011,723 in 1910, and an increase in quantity but a decrease in value for the second group as compared with the production in 1910, which was 62,647 long tons, valued at $1,411,779. The sales of alloys of iron with the rarer metals, molybdenum, titanium, tungsten, vanadium, and others not specified, amounted in 1911 to 4,638 long tons, valued at $2,285,407, or an average price of nearly $493 per ton. Of this total the quantity of ferrotitanium predominated. There are no statistics of the production of these latter alloys in 1910 for comparison.

The following table gives a partial outline of the ferro-alloy market in the United States in 1910 and 1911:

*Marketed production of ferro-alloys in 1910 and 1911.*

| Kind of alloy. | 1910 | | 1911 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| | *Long tons.* | | *Long tons.* | |
| Ferromanganese and spiegeleisen | 226,216 | $6,011,723 | 178,615 | $4,746,541 |
| Ferrosilicon and ferrophosphorus | 62,647 | 1,411,779 | 70,122 | 1,345,884 |
| Ferromolybdenum, Ferrotitanium (10 to 20 per cent titanium), Ferrovanadium, Ferrotungsten (about 50 per cent tungsten), Other | (a) | (a) | 4,638 | 2,285,407 |
| Total | 288,863 | 7,423,502 | 253,375 | 8,377,832 |

a Not collected for 1910 by United States Geological Survey.

IMPORTS.

According to the Bureau of Statistics, the imports for consumption of ferromanganese into the United States in 1911 were 80,263 long tons, valued at $3,015,062, as compared with 114,228 long tons, valued at $4,341,071, in 1910, and those of spiegeleisen in 1911 were 20,970 long tons, valued at $405,444, as compared with 25,383 long tons, valued at $489,049, in 1910. The imports of the alloys of the rarer metals are not all reported separately. For instance, the imports of ferrochrome are combined with those of chromium; those of ferromolybdenum are combined with those of the metal molybdenum, and those of ferrotungsten are included with those of tungsten. For the sake of comparison, however, such statistics as are available are presented in the following table:

*Imports of ferro-alloys in 1910 and 1911, in long tons.*

| | Value per ton. | 1910 | | 1911 | |
|---|---|---|---|---|---|
| | | Long tons. | Value. | Long tons. | Value. |
| Chrome or chromium and ferrochrome. | $200 or less | 446 | $41,090 | 240.03 | $20,173 |
| | More than $200 | 53 | 38,339 | 13.50 | 7,729 |
| Total | | 499 | 79,429 | 253.53 | 27,902 |
| Ferrophosphorus | Less than $200 | 146 | 5,171 | 186.13 | 8,520 |
| Ferrosilicon | 15 per cent or less silicon | 2,240 | 44,115 | | |
| | More than 15 per cent silicon | 9,152.14 | 483,042 | 6,658.00 | 341,681 |
| Total | | 11,392.14 | 527,157 | | |
| Ferrovanadium | More than $300 | 0 | 0 | 1.07 | 2,623 |
| Molybdenum and ferromolybdenum. | More than $200 | 9.04 | 14,402 | 8.50 | 11,409 |
| Ferrotitanium | $200 or less | 1.04 | 260 | .69 | 97 |
| | More than $200 | 1.00 | 507 | 45.00 | 22,403 |
| Total | | 2.04 | 767 | 45.69 | 22,500 |
| Tungsten and ferrotungsten. | More than $200 | 528 | 678,534 | 115.07 | 143,802 |
| Ferromanganese | | 114,228 | 4,341,071 | 80,263 | 3,015,062 |
| Spiegeleisen | | 25,383 | 489,049 | 20,970 | 405,444 |

## ELECTRIC SMELTING OF IRON ORE.

The direct reduction of iron ore by means of the electric current is a problem that has engaged the attention of certain electrometallurgists for the last 10 or 12 years. According to Kershaw [1] the first experiments were made by Capt. Stassano, an Italian, at Rome, in 1899–1901, and later at Darfo, in northern Italy, where cheaper electric power was available. Stassano's furnace was of a revolving arc type with 3-phase current and water-cooled electrodes, and this type of furnace is still employed by Stassano for refining steel by electricity. Stassano's experiments proved that good iron could be produced in this way direct from the ore. The iron ore was first ground, and after mixing with lime and coke, was briquetted before being charged into the furnace—an expensive preliminary treatment. The power required in this process was estimated to be 2,866 kilowatt hours per ton, costing $18.60, and when the cost of materials and labor were added to the already exorbitant power cost the impracticability of the process from a financial standpoint was readily

[1] Kershaw, J. B. C., Electric furnace methods of iron production: Iron Trade Rev., Jan. 4, 1912, pp. 41–46.

apparent. Keller, a French electrometallurgist, carried on extended experiments in his own electric furnace at Kerrouse and Livet, France, from 1901 to 1905. In the Keller process the ore, coke, and limestone were coarsely crushed and mixed before charging into the furnace, which had two shafts connected below by a canal which collected the molten iron. A reduction in power and costs were accomplished by the Keller process, which is estimated to have required 2,292 kilowatt hours of power for a ton of 2,000 pounds at a cost of $12.05.

In America Heroult, another French electrometallurgist, made a trial of a shaft type of furnace at Sault Ste. Marie, Canada, in 1905–6, under the auspices of the Canadian Government. This early Heroult furnace was of the square shaft type and was much simpler than those of Stassano and Keller, and by its use it was estimated that the consumption of power for a large plant would approximate 1,490 kilowatt hours per ton of pig iron, at a cost of only $2.43. The estimated cost of native magnetite iron ore was $1.50 per ton; of charcoal, which was used instead of coke, $6 per ton of iron; and of labor about 76 cents—a total cost of $10.69 for labor, ore, and power supply requisite for a ton of pig iron. These costs were not, however, attained by actual practice, and the project of establishing an electric iron smelting industry on the Canadian side of the Great Lakes was, temporarily at least, abandoned. In 1906 to 1910 three Swedish engineers, Gronwall, Lindblad, and Stalhane, carried on extensive experimental work on the problem, building with the assistance of a number of iron manufacturers in Sweden two electric furnaces at Domnarfvet, and a third at Trollhättan. The design of the Gronwall electric furnace is similar to that of a miniature blast furnace with the tuyeres replaced by electrodes. Dr. Haanel, director of the mines branch of the Canada Department of Mines, made a series of test trials with the Gronwall furnace at Domnarfvet in 1908, using Grangesberg magnetite. Based on the yield under favorable conditions it has been estimated that the power consumption might be reduced to less than 2,000 kilowatt hours per ton of pig iron, and that for a furnace producing 8,000 to 10,000 tons of pig iron per annum the cost of charcoal, power, labor, electrodes, and repairs should total about $8.56 per ton of iron, to which must be added for cost of ore, interest on capital, depreciation of plant, machinery, etc., about $5 per ton, making the total cost of a ton of pig iron $13.56. At Trollhättan, where there is abundant water power, a much larger plant has been erected than at Domnarfvet. This plant was completed late in 1910 and has made a considerable quantity of pig iron said to be of exceptionally good quality, containing only small percentages of sulphur and phosphorus. Since this furnace has been operating the weekly production of pig iron has been increased, the electrode consumption has been greatly decreased, the consumption of charcoal has been decreased, and the power consumption has been reduced to an equivalent of only 1,735 kilowatt hours per ton of 2,204 pounds of pig iron, at a cost of $13 for the power. It is expected that the year 1912 will witness an extension of the Scandinavian electric smelting industry, four large electric pig iron furnaces of the Gronwall type having been planned for erection at Domnarfvet and Hagfors, Sweden, and at Tyassaa, Norway. Thus it seems that the future of the electric iron smelting industry in Scan-

dinavia is fairly well assured. This is due mainly to the favorable conditions that prevail there. High-grade iron ore, carrying between 60 and 65 per cent of metallic iron, is abundant, and electric power, developed from large waterfalls, is relatively cheap. There are no coal beds, and charcoal must be used for iron making. Charcoal is produced from the abundant timber, but the possibility of replacing two-thirds of the quantity required in iron making by electric power is a very important factor.

In the United States the only locality in which electric iron smelting has been attempted is in northern California. Here the physical conditions resemble in many ways those in Scandanavia, just described. No coking coal beds are near at hand, but timber for making charcoal is plentiful. Electric power is produced in excess of the demand from industries outside of iron smelting, but the water supply is limited in summer and autumn. The pig iron market in San Francisco is favorable to a small local iron industry, since heretofore supplies have had to be shipped mainly from Illinois and Colorado, or imported from abroad. A Heroult furnace was erected in Shasta County for the Noble Electric Steel Co., and placed in operation in July, 1907. This furnace is described by R. L. Phelps.[1] It was designed to utilize 1,500 kilowatts in the form of 3-phase current at 50 volts. The charge consisted of charcoal, limestone, and magnetite. The heat for smelting the ore resulted from the resistance of the slag and charge to the current as it passed from the electrodes to the neutral point at the bottom of the furnace. At the start the electrodes were in slight contact with the neutral bottom of the furnace, but as the charge became heated the electrodes were drawn out of the molten iron and remained in the slag and charge. It did not fulfill expectations, however, the output never exceeding 11 tons of pig iron per day, and a second furnace, designed by Prof. Dorsey Lyon,[2] was erected. This furnace was smaller than the first, being of 160 kilowatt capacity, and was designed to run with 4,000 amperes at 35 volts, single-phase current. This furnace differed considerably in design from the first one erected. It was started early in 1908 and made an experimental run for 46 days. The lowest power consumption reported to have been attained was 3,066 kilowatt hours per ton of pig iron. The output of the furnace was 2,400 pounds of iron in 24 hours. In order to reduce this power consumption a larger furnace capable of continuous runs was next erected. This third furnace is built on the same general lines as the second, but has a capacity of 1,500 kilowatts and employs 3-phase current. The charge is dried in a preheater which utilizes stack gases, and the charging is done mechanically. There are six electrodes arranged equidistantly around the furnace, and the current passing through the ore lying between them in the crucible melts the charge. The molten metal and the slag are drawn off as in ordinary blast-furnace practice. Charcoal for this plant is supplied by a wood carbonizing plant which has been erected near the furnace, and such by-products as wood alcohol, acetic acid, tar, and creosote oils are obtained. Kershaw[3] gives a tabular summary of comparative costs of electrically produced pig iron, which is given below, with the addition of dates.

---

[1] Phelps, R. L., The electrical smelting of iron ore: Min. and Sci. Press, July 20, 1907, pp. 87–88.
[2] Lyon, Dorsey, Trans. Electromet. Soc., vol. 15, 1909, pp. 39–49.
[3] Kershaw, J. B. C., op. cit., p. 45.

*Comparative costs of electrically produced pig iron.*

| Date. | Type of furnace. | Location. | Power kilowatt hours. | Estimated cost (2,204 pounds). | Notes. |
|---|---|---|---|---|---|
| 1903 | Stassano | Darfo, Italy | 2,866 | $18.60 | Power at $9 per electric horsepower year. |
| 1904 | Keller | Livet, France | 2,589 | 13.27 | |
| 1906 | Heroult | Sault Ste. Marie, Canada | 1,642 | 11 77 | Power at $10.71 per electrical horsepower year; ore $1.50 per ton. |
| 1908 | Gronwall | Trollhättan, Sweden | 1,957 | 13.56 | Estimate based on early trials. |
| 1910 | do | do | 1,735 | 13.00 | Actual results obtained at Trollhättan, Sept. 3, 1911. |
| 1910 | Heroult | Heroult, Shasta Co., Cal. | | 15.00 | Power at $12 per electrical horsepower year; ore, $1.50 per ton. |

With regard to the future of electric smelting of pig iron there are certain controlling factors that will doubtless limit it to localities like Trollhättan and Heroult where all physical and commercial conditions are favorable to its development. The main point seems to be that the saving in coke effected by the use of electric heating is so small that electric power must be produced or sold at a cost of $8 to $10 per electrical horsepower year, a figure far below the possibilities of the great majority of hydroelectric power stations at present. The electric process is also further handicapped by the cost of carbon electrodes, an expense which the ordinary blast furnace does not have to bear. These conclusions, it should be noted, have no bearing on the refining of steel in the electric furnace, a practice which is already established, and is rapidly expanding in Europe and America.

A few of the recent papers in English bearing on the subject of production of pig iron by the use of electric energy are given in the following list:

*Publications on electric smelting of iron ore.*


Anon., Electric iron ore smelting at Trollhättan, Sweden: Engineering, June 16, 1911, pp. 778–781.

Anon., The Trollhättan hydro-electric power station, Sweden: Engineering, Sept. 22, 1911, pp. 374–379.

Bennie, P. McN., Electric furnace pig iron in California: Trans. Am. Electrochem. Soc., vol. 15, 1909, pp. 35–37.

——— Progress in electrosiderurgy: Quart. Bull. Canadian Min. Inst., June, 1910; pp. 31–46.

——— Electric furnace—its place in siderurgy: Proc. Eng. Soc. Western Pennsylvania, January, 1911.

Campbell, D. F., Progress in the electrometallurgy of iron and steel (abstr. read to Faraday Soc., October, 1911): Iron and Coal Trade Rev., Oct. 13, 1911, p. 611.

Catani, R., Large electric furnaces in the electrometallurgy of iron and steel: Trans. Am. Electrochem. Soc., vol. 15, 1909, pp. 159–171. (See also Iron and Steel Inst. Jour., October, 1911, and Iron and Coal Trades Rev., Oct. 6, 1911.)

——— The applications of electricity in the metallurgical industry of Italy: Met. and Chem. Eng., December, 1911, pp. 642–649.

Frick, Otto, The electric reduction of iron ores (with special reference to Trollhättan, Sweden, and Noble furnace at Heroult, Cal.): Met. and Chem. Eng., December, 1911; pp. 631–637.

Fuller, S. J., Production of pig iron by electricity (reviews Trollhättan experiments): U. S. Cons. Repts., July 19, 1911, p. 273; Oct. 14, 1911, p. 248.

Haanel, Eugene, Report of committee appointed to investigate the different electrothermic processes for the smelting of iron ores and the making of steel in Europe: Dept. Interior, Ottawa, Canada, 1904.

HAANEL, EUGENE, The electric shaft furnace of the Aktiebolaget Elektrometall, Ludviga, Sweden: Trans. Am. Electrochem. Soc., vol. 15, 1909, pp. 25–33.
——— Recent advances in the construction of electric furnaces for the production of pig iron, steel, and zinc: Bull. Canada Dept. Mines No. 3, Ottawa, 1910, 76 pp.
KELLER, C. A., A contribution to the study of electric furnaces as applied to the manufacture of iron and steel: Trans. Am. Electrochem. Soc., vol. 15, 1909, pp. 87–125.
KERSHAW, J. B. C., Electric furnace methods of iron production (recent developments in electric iron ore smelting mediums, with descriptions of the various furnaces in use): Iron Trade Rev., Jan. 4, 1912, pp. 41–46.
KNESCHE, J. A., Electric smelting of ore in the United States: Iron Trade Rev., Jan. 5, 1911, pp. 65–77. Illus.
LEFFLER, J. A., Electric iron smelting at Trollhättan, Sweden: Iron and Coal Trade Rev., June 9, 1911, pp. 957–962.
——— Electric iron ore smelting at Trollhättan, Sweden: Engineering, June 16, 1911, pp. 778–780; June 23, pp. 811–814; June 30, pp. 846–847.
——— An electric furnace for smelting iron ore: Iron Trade Rev., July 20, 1911, pp. 121–124.
——— The electric iron reduction plant at Trollhättan, Sweden: Met. and Chem. Eng., July, 1911, pp. 368–371; September, 1911, pp. 459–463; and October, 1911, pp. 505–508.
LYON, D. A., The Noble Electric Steel Co.'s plant: Trans. Am. Electrochem. Soc., vol. 15, 1909, pp. 39–49.
PHELPS, R. L., The electrical smelting of iron ore: Min. and Sci. Press, July 20, 1907, pp. 87–88.
RICHARDS, J. W., The electric furnace reduction of iron ore: Trans. Am. Electrochem. Soc., vol. 15, 1909, pp. 53–61.
——— Electrometallurgical revolution in the iron and steel industry of Norway and Sweden: Proc. Eng. Soc. of Western Pennsylvania, May, 1911.
ROBERTSON, T. D., Recent progress in electrical iron smelting in Sweden: Trans. Am. Electrochem. Soc., September, 1911, pp. 375–401. Abstract in Met. and Chem. Eng., October, 1911, p. 525; Iron Age, Oct. 12, 1911, p. 804; Min. and Sci. Press, Oct. 21, 1911, p. 525.
——— Electrical iron smelting in Sweden (at Trollhättan, read to Eng. Club of Toronto, abstract): Canadian Eng., Nov. 9, 1911, pp. 544–547.
STANSFIELD, A., Electric smelting. Steel direct from the ore in the electric furnace: Can. Eng., Nov. 16, 1911, pp. 574–575.
STASSANO, ERNESTO, The application of the electric furnace to siderurgy: Trans. Am. Electrochem. Soc., vol. 15, 1909, pp. 63–85.
TAYLOR, E. R., Electric furnace for the smelting of iron ore: Trans. Am. Inst. Chem. Eng., vol. 2, 1909, pp. 280–296.
TYSSOWSKI, JOHN, Electric smelting of iron ore at Heroult, Cal.: Eng. and Min. Jour., Aug. 6, 1910, pp. 269–271.
VAN BRUSSEL, J. B., The Trollhättan electric smeltery: Eng. and Min. Jour., Sept. 30, 1911, pp. 650–652.
VAN LANGENDONCK, C., Electric smelting in Sweden: Eng. News, Jan. 11, 1912, pp. 61–63.

## PRODUCTION OF STEEL BY STATES AND KINDS.

The following five tables show the production of the various steels, according to the statistical report for 1911 of the American Iron and Steel Association. The production of Bessemer steel ingots and castings in the leading States from 1907 to 1911, inclusive, was as follows:

*Production of Bessemer ingots and castings, 1907–1911, by States, in long tons.*

| State. | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|
| Pennsylvania | 4,351,841 | 2,106,382 | 2,845,602 | 2,975,750 | 2,338,813 |
| Ohio | 3,636,679 | 1,955,446 | 3,466,077 | 3,314,053 | 3,268,994 |
| Illinois | 1,723,073 | 1,237,747 | 1,632,444 | 1,693,053 | 1,335,053 |
| Other States | 1,955,956 | 817,180 | 1,386,660 | 1,429,916 | 1,004,994 |
| Total | 11,667,549 | 6,116,755 | 9,330,783 | 9,412,772 | 7,947,854 |

In the following table is given the production of open-hearth steel ingots and castings in the leading States from 1907 to 1911, inclusive:

*Production of open-hearth steel ingots and castings, 1907–1911, by States, in long tons.*

| State. | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|
| New England States | 239,797 | 158,417 | 257,392 | 223,158 | 189,879 |
| New York and New Jersey | 706,019 | 350,348 | 618,117 | 713,245 | 679,152 |
| Pennsylvania | 7,868,353 | 5,322,229 | 9,400,287 | 10,153,816 | 9,594,914 |
| Ohio | 819,642 | 525,171 | 1,424,452 | 1,733,409 | 1,721,549 |
| Indiana | 181,662 | 167,299 | 783,957 | 1,307,129 | 1,394,520 |
| Illinois | 1,013,251 | 483,104 | 1,052,572 | 995,011 | 801,624 |
| Other States | 721,012 | 830,161 | 957,159 | 1,378,741 | 1,217,012 |
| Total | 11,549,736 | 7,836,729 | 14,493,936 | 16,504,509 | 15,598,650 |

The following table gives the production, by States, of basic and acid open-hearth steel ingots and castings in 1911:

*Production of basic and acid open-hearth steel ingots and castings in 1911, by States, in long tons.*

| State. | Basic open-hearth steel. | Acid open-hearth steel. | Total. |
|---|---|---|---|
| New England States | 155,488 | 34,391 | 189,879 |
| New York and New Jersey | 630,421 | 48,731 | 679,152 |
| Pennsylvania | 8,913,868 | 681,046 | 9,594,914 |
| Ohio | 1,670,481 | 51,068 | 1,721,549 |
| Indiana | 1,371,614 | 22,906 | 1,394,520 |
| Illinois | 767,383 | 34,241 | 801,624 |
| Other States | 1,176,677 | 40,335 | 1,217,012 |
| Total | 14,685,932 | 912,718 | 15,598,650 |

The following table gives the production of all kinds of steel ingots and castings in 1910 and 1911:

*Production of all kinds of steel ingots and castings in 1910 and 1911, by States, in long tons.*

| State. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Bessemer. | Open-hearth. | Crucible and all other. | Total ingots and castings. | Bessemer. | Open-hearth. | Crucible and all other. | Total ingots and castings. |
| Massachusetts, Rhode Island, Maine, and Connecticut | 2,592 | 223,158 | 23,751 | 249,501 | 1,411 | 189,879 | 20,004 | 211,294 |
| New York and New Jersey | 740,529 | 713,245 | 34,856 | 1,488,630 | 355,717 | 679,152 | 34,692 | 1,069,561 |
| Pennsylvania | 2,975,750 | 10,153,816 | 77,973 | 13,207,539 | 2,338,813 | 9,594,914 | 56,796 | 11,990,523 |
| Delaware, Maryland, District of Columbia, Virginia, West Virginia, Kentucky, Georgia, Alabama, Louisiana, and Texas[a] | 589,949 | 897,219 | ..... | 1,487,168 | 529,799 | 764,934 | 100 | 1,294,833 |
| Ohio | 3,314,053 | 1,733,409 | 3,146 | 5,050,608 | 3,268,994 | 1,721,549 | 3,567 | 4,994,110 |
| Indiana and Illinois | 1,693,053 | 2,302,140 | 31,247 | 4,026,440 | 1,335,053 | 2,196,144 | 7,596 | 3,538,793 |
| Other States | 96,846 | 481,522 | 6,665 | 585,033 | 118,067 | 452,078 | 6,847 | 576,992 |
| Total | 9,412,772 | 16,504,509 | 177,638 | 26,094,919 | 7,947,854 | 15,598,650 | 129,602 | 23,676,106 |

[a] Figures for 1911 include Tennessee.

## PRODUCTION OF ELECTRIC AND MISCELLANEOUS STEEL.

Statistics of the American Iron and Steel Association show that the total electric production of steel in 1911 was 29,105 long tons as compared with 52,141 tons in 1910, a decrease of 23,036 tons. In 1911 there were 9 plants which made steel by the electric process as follows: Massachusetts, 1; New York, 3; Pennsylvania, 3; Indiana, 1; and Illinois, 1; as compared with a total of 7 plants in 1910 in the same States. In 1911 about 27,227 tons were ingots and about 1,878 tons were castings, and in 1910 about 50,821 tons were ingots and about 1,320 tons were castings. The total production of electric steel in 1911 includes about 6,722 tons of alloy steel ingots and castings of which about 6,612 tons were ingots and about 110 tons were castings. In 1910 the production of electric alloy steel was about 608 tons, of which 600 tons were ingots and 8 tons were castings.

## TOTAL PRODUCTION OF STEEL.

The statistics of the production of various kinds of steel, so far as has been recorded, are given in the following table. The first steel produced in this country was probably made in Connecticut in 1728 by Samuel Higley and Joseph Dewey. Crucible steel was first successfully produced in the United States in 1832 at the works of William and John H. Garrard, at Cincinnati, Ohio. Bessemer steel was first made in this country in September, 1864, by William F. Durfee at an experimental plant at Wyandotte, Mich., and open-hearth steel in 1864 by the New Jersey Steel & Iron Co. at Trenton, N. J.

*Production of steel in the United States, 1810–1911, in long tons.*

| Year. | Bessemer. | Open-hearth. | Crucible. | Other steel. | Total. |
|---|---|---|---|---|---|
| 1810 | ..... | ..... | 917 | | 917 |
| 1860 | ..... | ..... | 11,838 | | 11,838 |
| 1863 | ..... | ..... | 8,075 | | 8,075 |
| 1864 | ..... | ..... | 9,258 | | 9,258 |
| 1865 | ..... | ..... | 13,627 | | 13,627 |
| 1866 | ..... | ..... | 16,940 | | 16,940 |
| 1867 | 2,679 | ..... | 16,964 | | 19,643 |
| 1868 | 7,589 | ..... | 19,197 | | 26,786 |
| 1869 | 10,714 | 893 | 19,643 | | 31,250 |
| 1870 | 37,500 | 1,339 | 29,911 | | 68,750 |
| 1871 | 40,179 | 1,785 | 31,250 | | 73,214 |
| 1872 | 107,239 | 2,679 | 26,125 | 6,911 | 142,954 |
| 1873 | 152,368 | 3,125 | 31,059 | 12,244 | 198,796 |
| 1874 | 171,369 | 6,250 | 32,436 | 5,672 | 215,727 |
| 1875 | 335,283 | 8,080 | 35,180 | 11,256 | 389,799 |
| 1876 | 469,639 | 19,187 | 35,163 | 9,202 | 533,191 |
| 1877 | 500,524 | 22,349 | 36,098 | 10,647 | 569,618 |
| 1878 | 653,773 | 32,255 | 38,309 | 7,640 | 731,977 |
| 1879 | 829,439 | 50,259 | 50,696 | 4,879 | 935,273 |
| 1880 | 1,074,262 | 100,851 | 64,664 | 7,558 | 1,247,335 |
| 1881 | 1,374,247 | 131,202 | 80,145 | 2,720 | 1,588,314 |
| 1882 | 1,514,687 | 143,341 | 75,973 | 2,691 | 1,736,692 |
| 1883 | 1,477,345 | 119,356 | 71,835 | 4,999 | 1,673,535 |
| 1884 | 1,375,531 | 117,515 | 53,270 | 4,563 | 1,550,879 |
| 1885 | 1,519,430 | 133,376 | 57,599 | 1,515 | 1,711,920 |
| 1886 | 2,269,190 | 218,973 | 71,973 | 2,367 | 2,562,503 |
| 1887 | 2,936,033 | 322,069 | 75,375 | 5,594 | 3,339,071 |
| 1888 | 2,511,161 | 314,318 | 70,279 | 3,682 | 2,899,440 |
| 1889 | 2,930,204 | 374,543 | 75,865 | 5,120 | 3,385,732 |
| 1890 | 3,688,871 | 513,232 | 71,175 | 3,793 | 4,277,071 |
| 1891 | 3,247,417 | 579,753 | 72,586 | 4,484 | 3,904,240 |
| 1892 | 4,168,435 | 669,889 | 84,709 | 4,548 | 4,927,581 |
| 1893 | 3,215,686 | 737,890 | 63,613 | 2,806 | 4,019,995 |
| 1894 | 3,571,313 | 784,936 | 51,702 | 4,081 | 4,412,032 |

*Production of steel in the United States, 1810–1911, in long tons*—Continued.

| Year. | Bessemer. | Open-hearth. | Crucible. | Other steel. | Total. |
|---|---|---|---|---|---|
| 1895 | 4,909,128 | 1,137,182 | 67,666 | 858 | 6,114,834 |
| 1896 | 3,919,906 | 1,298,700 | 60,689 | 2,394 | 5,281,689 |
| 1897 | 5,475,315 | 1,608,671 | 69,959 | 3,012 | 7,156,957 |
| 1898 | 6,609,017 | 2,230,292 | 89,747 | 3,801 | 8,932,857 |
| 1899 | 7,586,354 | 2,947,316 | 101,213 | 4,974 | 10,639,857 |
| 1900 | 6,684,770 | 3,398,135 | 100,562 | 4,862 | 10,188,329 |
| 1901 | 8,713,302 | 4,656,309 | 98,513 | 5,471 | 13,473,595 |
| 1902 | 9,138,363 | 5,687,729 | 112,772 | 8,386 | 14,947,250 |
| 1903 | 8,592,829 | 5,829,911 | 102,434 | 9,804 | 14,534,978 |
| 1904 | 7,859,140 | 5,908,166 | 83,391 | 9,190 | 13,859,887 |
| 1905 | 10,941,375 | 8,971,376 | 102,233 | 8,963 | 20,023,947 |
| 1906 | 12,275,830 | 10,980,413 | 127,513 | 14,380 | 23,398,136 |
| 1907 | 11,667,549 | 11,549,736 | 131,234 | 14,075 | 23,362,594 |
| 1908 | 6,116,755 | 7,836,729 | 63,631 | 6,132 | 14,023,247 |
| 1909 | 9,330,783 | 14,493,936 | 107,355 | 22,947 | 23,955,021 |
| 1910 | 9,412,772 | 16,504,509 | 122,303 | 55,335 | 26,094,919 |
| 1911 | 7,947,854 | 15,598,650 | 97,653 | 31,949 | 23,676,106 |

## BIBLIOGRAPHY.

PUBLICATIONS ON EASTERN AND SOUTHERN IRON ORES.


Alabama Geological Survey, various reports.

Anon., Iron and zinc in southeastern Virginia: Eng. and Min. Jour., Nov. 7, 1908, p. 908.

Archer, G. F., Future of Adirondack iron: Sibley Jour. Eng., June, 1908.

Bayley, W. S., Iron mines and mining in New Jersey: New Jersey Geol. Survey, vol. 8, 1910.

Boyd, C. R., The mineral wealth of southwestern Virginia: Trans. Am. Inst. Min. Eng., vol. 5, 1877, pp. 81–92; vol. 8, 1880, pp. 338–348.

——— Resources of southwest Virginia, New York, 1881, 321 pp.

——— The economic geology of the Bristol and Big Stone Gap section of Tennessee and Virginia: Trans. Am. Inst. Min. Eng., vol. 15, 1887, pp. 114–141.

——— Middlesboro, Ky.: Eng. and Min. Jour., vol. 49, 1890, pp. 171–173.

Burchard, E. F., The iron ores of the Brookwood district, Alabama: Bull. U. S. Geol. Survey No. 260, 1905, pp. 321–334.

——— The Clinton or red ores of the Birmingham district, Alabama: Bull. U. S. Geol. Survey No. 315, 1907, pp. 130–151.

——— The brown iron ores of the Russellville district, Alabama: Bull. U. S. Geol. Survey No. 315, 1907, pp. 152–160.

——— The Clinton iron ore deposits in Alabama: Trans Am. Inst. Min. Eng., vol. 39, 1908, pp. 997–1055.

——— Tonnage estimates of Clinton iron ore in the Chattanooga district of Tennessee, Georgia, and Alabama: Bull. U. S. Geol. Survey No. 380, 1909, pp. 169–187.

Burchard, E. F., Butts, Charles, and Eckel, E. C., Iron ores, fuels, and fluxes of the Birmingham district, Alabama: Bull. U. S. Geol. Survey No. 400, 1909.

Butts, Charles, Economic geology of the Kittanning and Rural Valley quadrangles, Pennsylvania: Bull. U. S. Geol. Survey No. 279, 1906, pp. 171–174.

——— Iron ores in the Montevallo-Columbiana region, Alabama: Bull. U. S. Geol. Survey No. 470-f, 1911, 18 pp.

Campbell, J. L., The Virginias, Staunton, Va., 1880–1885, 6 vols.

Catlett, C., A new theory of the genesis of brown hematite ores and a new source of sulphur supply. (Discussion of paper by H. M. Chance): Bi-mo. Bull. No. 24, Am. Inst. Min. Eng., 1908.

——— Iron ores of the Potsdam formation in the Valley of Virginia: Trans. Am. Inst. Min. Eng., vol. 29, 1899, pp. 308–317.

Chance, H. M., The Rich Patch iron tract, Virginia: Trans. Am. Inst. Min. Eng., vol. 29, 1900, pp. 210–223.

Eckel, E. C., The Clinton hematite (in New York): Eng. and Min. Jour., vol. 79, 1905, pp. 897–898.

——— Limonite deposits of eastern New York and western New England: Bull. U. S. Geol. Survey No. 260, 1905, pp. 335–342.

——— The Clinton or red ores of northern Alabama: Bull. U. S. Geol. Survey No. 285, 1906, pp. 172–179.

ECKEL, E. C., The Oriskany and Clinton iron ores of Virginia: Bull. U. S. Geol. Survey No. 285, 1906, pp. 183–189.
——— Gray hematites of eastern Alabama: Iron Trade Rev., Aug. 6, 1908.
——— Clinton or red ores of Georgia: Iron Trade Rev., Jan. 7, 1909.
GEISMER, H. S., Prospecting for brown iron ores: Eng. and Min. Jour., Sept. 9, 1911, pp. 498–500.
GRASTY, J. S., The gray ores of Alabama: Manufacturers' Record, vol. 50, 1906, pp. 550–553.
HARDER, E. C., The iron ores of the Appalachian region in Virginia: Bull. U. S. Geol. Survey No. 380, 1909, pp. 215–254.
——— Structure and origin of the magnetite deposits near Dillsburg, York County, Pa.: Economic Geology, vol. 5, No. 7, October–November, 1910, pp. 599–622.
HAUSMANN, F. W., Brown ore mining in the Russellville district: Stevens Inst. Indicator, January, 1908.
HAYES, C. W., Geological relations of the iron ores in the Cartersville district, Georgia: Trans. Am. Inst. Min. Eng., vol. 30, 1910, pp. 403–419.
HAYES, C. W., and ECKEL, E. C., Iron ores of the Cartersville district, Georgia: Bull. U. S. Geol. Survey No. 213, 1903, pp. 233–242.
HIGGINS, E., Iron operations of the Birmingham district: Eng. and Min. Jour., Nov. 28, 1908.
——— Iron operations in northeastern Alabama: Eng. and Min. Jour., Dec. 5, 1908.
——— Stripping Clinton iron ore in New York State: Eng. and Min. Jour., Dec. 12, 1908.
——— Iron operations in the Chattanooga district: Eng. and Min. Jour., Jan. 2,1909.
HOLDEN, R. J., The brown ores of the New River-Cripple Creek district, Virginia: Bull. U. S. Geol. Survey No. 285, 1906, pp. 190–193.
——— Iron: Mineral resources of Virginia, 1907, p. 402.
HOPKINS, T. C., Cambro-Silurian limonite ores of Pennsylvania: Bull. Geol. Soc. America, vol. 2, 1900, pp. 475–502.
HUNGERFORD, W. S., Mining in soft ore bodies at Low Moor: Trans. Am. Inst. Min. Eng., vol. 17, 1889, pp. 103–107.
JOHNSON, B. L., Notes on the history and geology of Iron Mine Hill, Cumberland, R. I.: Am. Jour. Sci., 4th ser., vol. 25, January, 1908.
JOHNSON, J. E., Jr., Origin of the Oriskany limonites (Virginia): Eng. and Min. Jour., vol. 76, Aug. 15, 1903, pp. 231–232.
KEITH, A., Iron-ore deposits of the Cranberry district, North Carolina-Tennessee: Bull. U. S. Geol. Survey No. 213, 1903, pp. 243–246.
KELLY, WILLIAM, The Clinton iron-ore deposits of Stone Valley, Huntingdon County, Pa.: Bi-mo. Bull. No. 25, Am. Inst. Min. Eng., 1909.
KEMP, J. F., The geology of the magnetites near Port Henry, N. Y., and especially those of Mineville: Trans. Am. Inst. Min. Eng., vol. 27, 1897, pp. 146–203.
——— The titaniferous iron ores of the Adirondacks (New York): Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1899, pp. 277–422.
KENTUCKY GEOLOGICAL SURVEY, Various parts.
KINDLE, E. M., The iron ores of Bath County, Ky.: Bull. U. S. Geol. Survey No. 285, 1906, pp. 180–182.
KÜMMEL, H. B., Iron ore in New Jersey: Eng. and Min. Jour., June 13, 1908.
LESLEY, J. P., and D'INVILLIERS, E. V., Ann. Rept. Second Geol. Survey Pennsylvania, 1887, pp. 491–570.
LYMAN, B. S., Geology of the Low Moor, Va., iron ores: Trans. Am. Inst. Min. Eng., vol. 14, 1886, pp. 801–809.
MCCALLIE, S. W., Preliminary report on the iron ores of Georgia: Bull. Georgia Geol. Survey No. 10, 1900, p. 190.
——— Report on the fossil iron ores of Georgia: Bull. Georgia Geol. Survey No. 17, 1908.
MCCREATH, A. S., and D'INVILLIERS, E. V., Mineral resources of the upper Cumberland Valley of southeastern Kentucky and southwestern Virginia, Louisville, 1902, 152 pp.
MCCROSSIN, E. F., Georgia brown iron-ore washeries: Mines and Minerals, December, 1910, p. 294.
MOORE, P. N., Kentucky Geol. Survey, vol. C.
——— Report on the iron ores in the vicinity of Cumberland Gap: Rept. Kentucky Geol. Survey, new ser., vol 4, 1878, pp. 241–254.
——— Report on Bath and Fleming counties, Ky.: Kentucky Geol. Survey, 1886.
MORGAN, D. F., The native ores of Jackson County, Ohio: Iron Trade Rev., Feb. 13, 1908.
MOXHAM, E. C., The "Great Gossan Lead" of Virginia: Trans. Am. Inst. Min. Eng., vol. 21, 1892, pp. 133–138.

Nason, F. L., The geological structure of the Ringwood iron mines, New Jersey: Trans. Am. Inst. Min. Eng., vol. 24, 1894, pp. 505–521.
Newland, D. H., and Hartnagel, C. A., Iron ores of the Clinton formation in New York State: Bull. New York State Mus. No. 123, 1908.
Newland, D. H., and Kemp, J. F., Geology of the Adirondack magnetic iron ores (New York): Bull. New York State Mus. No. 119, 1908.
Nitze, H. B. C., Iron ores of North Carolina: Bull. North Carolina Geol. Survey No. 1, 1893, 239 pp.
——— The magnetic iron ores of Ashe County, N. C.: Trans. Am. Inst. Min. Eng., vol. 21, 1892, pp. 250–280.
North Carolina Geological Survey, Various reports.
Ohio Geological Survey, Various reports.
Orton, E., Ohio Geological Survey, vol. 5.
Pechin, E. C., The iron ores of Virginia and their development: Trans. Am. Inst. Min. Eng., vol. 19, 1891, p. 1016.
——— Report on the property of the Rich Patch Iron Co., Staunton, Va., 1892, 13 pp.
——— Virginia Oriskany iron ores: Eng. and Min. Jour., vol. 54, 1892, p. 150.
——— The Oriskany ores at Rich Patch mines, Virginia: Eng. and Min. Jour., vol. 61, 1896, pp. 113, 134, 159–160.
Pennsylvania Geological Survey, Various reports.
Phalen, W. C., Origin and occurrence of certain iron ores of northeastern Kentucky: Econ. Geology, vol. 1, No. 7, 1906, pp. 660–669.
——— Economic geology of the Kenova quadrangle, Kentucky, Ohio, and West Virginia: Bull. U. S. Geol. Survey No. 349, 1908, pp. 122–130.
Phalen, W. C., Iron ores near Ellijay, Ga.: Bull. U. S. Geol. Survey No. 340, 1908, pp. 330–334.
Phillips, W. B., Iron making in Alabama: Rept. Alabama Geol. Survey 2d ed., 1908.
——— Brown iron ores of Alabama: Iron Age, June 4, 11, 25, July 9, Aug. 6, and Sept. 3, 1908.
——— A great southern iron-ore reserve: Manufacturers' Record, Feb. 4, 1909.
Porter, J. J., The Virginia iron industry: Manufacturers' Record, vol. 51, 1907, pp. 717–719, 749–752, 788–790.
Rutledge, J. J., The Clinton iron-ore deposits of Stone Valley, Huntingdon County, Pa.: Trans. Am. Inst. Min. Eng., vol. 39, 1908.
Singewald, J. T., Report on the iron ores of Maryland: Maryland Geol. Survey, vol. 9, pt. 3, 1911, pp. 123–337.
Smith, E. A., The iron-ore industry in Alabama: Eng. and Min. Jour., June 6, 1908.
Smith, P. S., The gray iron ores of Talladega County, Ala.: Bull. U. S. Geol. Survey No. 315, 1907, pp. 161–184.
Smock, J. C., Iron mines and iron-ore districts in the State of New York: Bull. New York State Mus. No. 7, 1889.
Spencer, A. C., Genesis of the magnetite deposits in Sussex County, N. J.: Min. Mag., vol. 10, 1904, pp. 377–381.
——— Magnetite deposits in Berks and Lebanon Counties, Pa.: Bull. U. S. Geol. Survey No. 315, 1907, pp. 185–189.
——— Magnetite deposits of the Cornwall type in Pennsylvania: Bull. U. S. Geol. Survey No. 359, 1908.
Stewart, C. A., The magnetite belts of Putnam County, N. Y.: School of Mines Quart., April, 1908, pp. 283–294.
Stolte, G. C., The Forest of Dean iron mine: Eng. and Min. Jour., May 30, 1908.
——— The Cheever mines, Port Henry, N. Y. (Magnetite; geology; mining; concentration): Eng. and Min. Jour., Oct. 21, 1911, pp. 809–812.
West Virginia Geological Survey, Various reports.
White, I. C., Pennsylvania Second Geol. Survey, Rept. Q.

PUBLICATIONS ON LAKE SUPERIOR IRON ORES.

Abbott, C. E., Iron-ore deposits of the Ely trough, Vermilion Range, Minnesota: Trans. Lake Superior Min. Inst., vol. 12, p. 116.
Adams, F. S., The iron formation of the Cuyuna Range: Econ. Geology, pt. 1, December, 1910, pp. 729–740; Econ. Geology, pt. 2, February, 1911, p. 60; Econ. Geology, pt. 3, March, 1911, pp. 156–180.
Anon, Iron ore in hundreds of millions of tons (Discusses Baraboo district, Wisconsin): Iron Age, Mar. 9, 1911, pp. 618–620.
——— New plant and blast furnace of the Northwestern Iron Co., Mayville, Wis.: Iron Trade Review, July 28, 1910, pp. 175–179. (Treats of the construction of this plant and of the extent of the ore supply.)

ANON, Swanzy iron-ore district: Iron Trade Rev., January, 1909.
BACON, D. H., The development of Lake Superior iron ores: Trans. Am. Inst. Min. Eng., vol. 27, 1897, pp. 341–344.
BAILEY, C. E., Mining methods on the Mesabi Range: Trans. Am. Inst. Min. Eng., vol. 27, 1897, pp. 529–536.
BAYLEY, W. S., The Menominee iron-bearing district of Michigan: Mon. U. S. Geol. Survey, vol. 42, 1904.
BOSS, C. M., Some dike features of the Gogebic iron range: Trans. Am. Inst. Min. Eng., vol. 27, 1897, pp. 556–563.
BRINSMADE, R. B., The great iron fields of the Lake Superior district: Min. Sci., Nov. 26, Dec. 3, Dec. 10, Dec. 17, Dec. 24, and Dec. 31, 1908, and Jan. 7, 1909.
CHAMBERLIN, T. C., Clinton iron-ore deposits: Geology of Wisconsin, 1873 to 1877, vol. 2, p. 327, and atlas.
CLEMENTS, J. M., The vermilion iron-bearing district of Minnesota: Mon. U. S. Geol. Survey, vol. 45, 1903.
CLEMENTS, J. M., SMYTH, H. L., BAYLEY, W. S., and VAN HISE, C. R., The Crystal Falls iron-bearing district of Michigan: Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 1–157; also Mon. U. S. Geol. Survey, vol. 36, 1899.
CONLIN, T., and O'BRIEN, P., Historical sketch of Menominee range: Proc. Lake Superior Min. Inst., vol. 16, August, 1911.
CROWELL, B., and MURRAY, C. B., The iron ores of Lake Superior (Geology, history, mines and mining, sampling, analysis, pricing, etc.), 1911, 186 pp. (book).
CROZE, W. W. J., Minnesota's great iron-mining industry: The Mining World, Oct. 15, 1910, pp. 717–721.
CUSHING, G. H., Iron-ore movement on the Great Lakes in 1911: Min. and Sci. Press, Jan. 6, 1912; pp. 43–44.
DENTON, F. W., Methods of iron mining in Northern Minnesota: Trans. Am. Inst. Min. Eng., vol. 27, 1897, pp. 344–390.
HURD, RUKARD, Iron ore manual, Lake Superior district, 1911 values: method and determination of 1911 prices, premiums, and penalties at Lake Erie, etc., F. M. Catlin, Capital Bank Bldg., St. Paul, Minn., 1911, p. 162.
IRVING, R. D., and VAN HISE, C. R., The Penokee iron-bearing series of Michigan and Wisconsin: Tenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1889, pp. 341–507; Mon. U. S. Geol. Survey, vol. 19, 1892.
JOPLING, J. E., The Marquette range—Its discovery, development, and resources: Trans. Am. Inst. Min. Eng., vol. 27, 1897, pp. 541–555.
LEITH, C. K., The Mesabi iron-bearing district of Minnesota: Mon. U. S. Geol. Survey, vol. 43, 1903.
——— A summary of Lake Superior geology with special reference to recent studies of the iron-bearing series: Trans. Am. Inst. Min. Eng., vol. 35, 1904, pp. 454–507.
——— The geology of the Cuyuna iron range, Minnesota: Econ. Geology, vol. 2, pp. 145–152. 1907.
LONGYEAR, E. J., Explorations on the Mesabi range: Trans. Am. Inst. Min. Eng., vol. 27, 1897, pp. 537–541.
MCDONALD, P. B., Recent discoveries in Iron River district, Michigan: Min. World, Apr. 29, 1911, pp. 887–888.
SMYTH, H. L., and FINLAY, J. R., The geological structure of the western part of the Vermilion range, Minnesota: Trans. Am. Inst. Min. Eng., vol. 25, 1895, pp. 595–645.
SOPER, E. K., The iron ranges of Minnesota: Eng. and Min. Jour., Apr. 15, 1911, pp. 766–770.
VALLAT, B. W., The Newport iron mine—Gogebic range; history, geology, mining equipment, and practice: Trans. Am. Inst. Min. Eng., October, 1911, pp. 903–921.
VAN HISE, C. R., The iron-ore deposits of the Lake Superior region: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 3, 1901, pp. 305–434.
VAN HISE, C. R., BAYLEY, W. S., and SMYTH, H. L., Preliminary report on the Marquette iron-bearing district of Michigan. Fifteenth Ann. Rept. U. S. Geol. Survey, 1894, pp. 477–650. Same with atlas: Mon. U. S. Geol. Survey, vol. 28, 1897.
VAN HISE, C. R., and LEITH, C. K., The geology of the Lake Superior region: Mon. U. S. Geol. Survey, vol. 52, 1911.
WEIDMAN, S., The Baraboo iron-bearing district of Wisconsin: Bull. Wisconsin Geol. and Nat. Hist. Survey No. 13, 1904.
WINCHELL, N. H., Structures of the Mesabi iron ore: Proc. Lake Superior Min. Inst., June, 1908.
——— A diamond-drill core section of the Mesabi rocks: Proc. Lake Superior Min. Inst., 1909, pp. 156–178; 1910, pp. 100–141, and 1911, pp. 61–69.
WOODBRIDGE, D. E., Vermilion iron-ore explorations (review of this Minnesota field): Iron Age, Apr. 20, 1911, pp. 990–992.

Woodbridge, D. E., Recent discoveries and mines of Vermilion range, Minnesota: Min. World, Apr. 22, 1911, pp. 827–830.
——— Lake Superior ore developments: Iron Age, Jan. 4, 1912, pp. 65–67.
——— Iron ore in Lake Superior district: Eng. and Min. Jour., Jan. 6, 1912, pp. 31–32.
——— Beneficiating Lake iron ores: Eng. and Min. Jour., Jan. 27, 1912, pp. 222–223.
Zapffe, C., Geology of Cuyuna iron-ore district, Minnesota (read to Am. Asso. Adv. Sci. Sect. E): Mining World, Mar. 18, 1911, pp. 585–588.

PUBLICATIONS ON MISSISSIPPI VALLEY AND GULF OF MEXICO IRON ORES.

Comstock, T. B., A preliminary report on the central mineral region of Texas: First Ann. Rept. Texas Geol. Survey, 1890, pp. 239–391.
——— Report on the geology and mineral resources of the central mineral region of Texas: Second Ann. Rept. Texas Geol. Survey, 1891, pp. 555–664.
Crane, G. W., The iron ores of Missouri: Bull. Missouri Bur. Geology and Mines. (In press.)
Eckel, E. C., Iron ores of northeastern Texas: Bull. U. S. Geol. Survey No. 260, 1905, pp. 348–353.
——— The iron industry of Texas: Iron Age, vol. 76, 1905, pp. 478–479.
Johnson, L. C., Report on the iron-ore regions of northern Louisiana and eastern Texas: House Doc. 195, 50th Cong., 1st sess., 1888.
Kennedy, W., Iron ores of east Texas: Trans. Am. Inst. Min. Eng., vol. 24, 1894, pp. 258–288.
——— The age of the iron ores of east Texas: Science, vol. 23, pp. 22–25.
Kennedy, W., and others. Report on the iron-ore district of eastern Texas: Second Ann. Rept. Texas Geol. Survey, 1891, pp. 7–326.
Nason, F. L., Iron ores of Missouri: Rept. Missouri Geol. Survey, vol. 2, 1892.
Ohnsorg, N. L., Hematite deposits of the Ozark uplift: Min. and Sci. Press, June 10, 1911, p. 790.
Paige, Sidney, Mineral resources of the Llano-Burnet region, Texas: Bull. U. S. Geol. Survey No. 450, 1911, pp. 26–29.
Penrose, R. A. F., jr., A preliminary report on the geology of the Gulf Tertiaries of Texas from Red River to the Rio Grande: First Ann. Rept. Texas Geol. Survey, 1890, pp. 3–100.
——— The Tertiary iron ores of Arkansas and Texas: Bull. Geol. Soc. America, vol. 3, 1891, pp. 47–50.
Phillips, W. B., Iron and steel making in Texas: Iron Age, Jan. 4, 1912, pp. 14–16; Jan. 11, 1912, pp. 141–143.

PUBLICATIONS ON WESTERN IRON ORES.

Aubury, L. E., Iron: Bull. California State Min. Bur. No. 38, 1906, p. 297.
Ball, S. H., The Hartville iron-ore range, Wyoming: Bull. U. S. Geol. Survey No. 315, 1907, pp. 190–205.
——— Titaniferous iron-ore of Iron Mountain, Wyoming: Bull. U. S. Geol. Survey No. 315, 1907, pp. 206–212.
Boutwell, J. M., Iron ores in the Uinta Mountains, Utah: Bull. U. S. Geol. Survey No. 225, 1904, pp. 221–228.
Chance, H. M., Iron mines of Hartville, Wyo.: Trans. Am. Inst. Min. Eng., vol. 30, 1900, pp. 987-1003.
Diller, J. S., Iron ores of the Redding quadrangle, California: Bull. U. S. Geol. Survey No. 213, 1903, pp. 219–220.
Harder, E. C., The Taylor Peak and Whitepine iron-ore deposits, Colorado: Bull. U. S. Geol. Survey No. 380, 1909, pp. 188–198.
Harder, E. C., and Rich, J. L., The Iron Age iron-ore deposit near Dale, San Bernardino County, Cal.: Bull. U. S. Geol. Survey No. 430, 1910, pp. 228–239.
Hershey, O. H., Amarillo iron and phosphate deposits: Min. and Sci. Press, Oct. 17, 1908, p. 535.
Jennings, E. P., Origin of the magnetic iron ores of Iron County, Utah: Trans. Am. Inst. Min. Eng., vol. 35, 1904, pp. 338–342.
Jones, C. C., An iron-ore deposit in the California desert region: Eng. and Min. Jour., Apr. 17, 1909.
——— Iron ores of the Southwest (southern California): Mines and Minerals, Apr., 1911, pp. 574–576.
Keyes, C. R., Iron deposits of the Chupadera Mesa: Eng. and Min. Jour., vol. 78, 1904, p. 632.
Lakes, A., The Great Cebolla River deposits: Colliery Engineer, vol. 16, 1896, p. 267.

LEITH, C. K., Iron ores in southren Utah: Bull. U. S. Geol. Survey No. 225, 1904, pp. 229–237.
——— Iron ores of the western United States and British Columbia: Bull. U. S. Geol. Survey No. 285, 1906, pp. 194–200.
LEITH, C. K., and HARDER, E. C., Iron ores of the Iron Springs district, southern Utah: Bull. U. S. Geol. Survey No. 338, 1908.
LINDGREN, WALDEMAR, A deposit of titanic iron ore from Wyoming: Science, new ser., vol. 16, 1902, pp. 984–985.
PAIGE, SIDNEY, The Hanover iron-ore deposits, New Mexico: Bull. U. S. Geol. Survey No. 380, 1909, pp. 199–214.
PRESCOTT, B., The occurrence and genesis of the magnetic ores of Shasta County, Cal.: Econ. Geology, vol. 3, 1908, No. 6, p. 465.
SMITH, G. O., and WILLIS, BAILEY, The Clealum iron ores, Washington: Trans. Am. Inst. Min. Eng., vol. 30, pp. 356–366. 1901.
UPHAM, W. E., Specular hematite deposits, Planet, Ariz.: Min. and Sci. Press, Apr. 15, 1911, pp. 521–523.
VALLET, B. W., The iron ores and system of mining at Sunrise mine, Wyoming: Min. Rep., Nov. 28, 1907.

PUBLICATIONS ON CUBAN IRON ORES.

ANON, Cuban ore deposits: Iron and Coal Trade Rev., May 1, 1908.
——— Iron mining in Cuba: Iron Age, vol. 81, Apr. 9, 1908, pp. 1149–1157.
——— The Mayari iron-ore district of Cuba: Iron Age, vol. 80, Aug. 15, 1907, pp. 421–426.
CHISHOLM, F. F., Iron-ore beds in the province of Santiago, Cuba: Proc. Colorado Sci. Soc., vol. 3, 1891, pp. 259–263.
COX, J. S., Jr., The iron-ore deposits of the Moa district, Oriente Province, Island of Cuba: Bull. Am. Inst. Min. Eng., Mar., 1911, pp. 199–216.
CUMINGS, W. L., and MILLER, B. L., Characteristics and origin of the brown iron ores of Camaguey and Moa, Cuba: Bull. Am. Inst. Min. Eng., Mar., 1911, pp. 247–267.
GRAHAM, T. H., Sigua iron mines, Cuba: Iron Age, vol. 41, 1888, p. 140.
HAYES, C. W., The Mayari and Moa iron-ore deposits in Cuba: Bull. Am. Inst. Min. Eng., Mar. 1911, pp. 239–245.
KIMBALL, J. P., Geological relations and genesis of the specular iron ores of Santiago de Cuba: Am. Jour. Sci., 3d ser., vol. 28, 1884, pp. 416–429.
——— The iron-ore range of the Santiago district of Cuba: Trans. Am. Inst. Min. Eng., vol. 13, 1885, pp. 613–634.
LEITH, C. K., and MEAD, W. J., Origin of the iron ores of central and northeastern Cuba: Bull. Am. Inst. Min. Eng., Mar., 1911, pp. 216–229
SOUDER, HARRISON, Mineral deposits of Santiago, Cuba: Trans. Am. Inst. Min. Eng., vol. 35, 1904, p. 313.
SPENCER, A. C., The iron ores of Santiago, Cuba: Eng. and Min. Jour., vol. 72, pp. 633–634. 1901.
——— Iron ores of Cuba: Ann. Rept. Military Governor of Cuba for 1901.
——— Three deposits of iron ore in Cuba: Bull. U. S. Geol. Survey No. 340, 1908, pp. 318–329.
——— Occurrence, origin, and character of the surficial iron ores of Camaguey and Oriente provinces, Cuba: Bull. Am. Inst. Min. Eng., Mar., 1911, pp. 231–237.
WELD, C. M., The residual brown iron ores of Cuba: Bull. Am. Inst. Min. Eng., Aug., 1909, pp. 749–762.
WOODBRIDGE, D. E., Exploration of Cuban iron-ore deposits: Bull. Am. Inst. Min. Eng., Mar., 1911, pp. 269–282.

GENERAL PUBLICATIONS ON IRON ORES.

ANON, Iron-ore resources of the world (summarized): Iron Age, Aug. 11, 1910, pp. 322–323.
BIRKINBINE, JOHN, Iron ores: Mineral Resources U. S., annual volumes from 1886, 1887, and 1889 to 1905, inclusive.
——— Iron ores: Eleventh Census U. S., 1890, Mineral industries, pp. 3–30.
——— Iron ore: Special Repts. Census Office, 1902, Mines and quarries, pp. 395–434.
——— The production of iron ores in various parts of the world: Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1894, pp. 21–218.
——— The iron-ore supply: Trans. Ann. Inst. Min. Eng., vol. 27, 1897, pp. 519–528.
——— Beneficiating iron ores: Iron Trade Review, Feb. 2, 1911, pp. 265–272. (Reviews roasting, washing, magnetic concentration, and briquetting of ores to increase iron percentage.)

Birkinbine, John, Iron ore and mining operation: Iron Trade Review, Jan. 5, 1911, pp. 49–63.
Burchard, E. F., Production of iron ore, pig iron, and steel in 1910: Mineral Resources U. S. for 1910, pt. 1, U. S. Geol. Survey, 1911, pp. 69–102.
Cabot, G. L., Pyritic origin of iron-ore deposits: Eng. and Min. Jour., Sept. 26, 1908.
Chance, H. M., A new theory of the genesis of brown hematite ores, and a new source of sulphur supply: Bi-mo. Bull. Am. Inst. Min. Eng., Sept., 1908.
——— Pyritic origin of iron-ore deposits: Eng. and Min. Jour., Aug. 29, 1908.
Eckel, E. C., Utilization of iron and steel slags: Bull. U. S. Geol. Survey No. 213, 1903, pp. 221–231.
——— Iron ores of the United States: Bull. U. S. Geol. Survey No. 260, 1905, pp. 317–320.
Eleventh International Geological Congress, The iron-ore resources of the world, 2 vols. and atlas, Stockholm, 1910.
Harder, E. C., The production of iron ore, pig iron, and steel in 1908: Mineral Resources U. S. for 1908, U. S. Geol. Survey, pt. 1, 1909, pp. 61–134.
Hayes, C. W., Iron ores of the United States: Papers on the conservation of natural resources: Bull. U. S. Geol. Survey No. 394, 1909.
——— The iron ores of the United States: Iron Age, Apr. 29, 1909.
Holden, R. J., Review of The Iron Ore Resources of the World: Econ. Geology, vol. 5, No. 7, Oct.–Nov., 1910, pp. 689–693.
Jeans, Harold, The world's export trade in iron and steel and its regulation: Iron and Coal Trade Rev., Nov. 27, 1908.
Kemp, J. F., A brief review of the titaniferous magnetites: School of Mines Quart., vol. 20, 1898–99, pp. 323–356.
——— The supply of iron: Min. Mag., Nov., 1910. (A contribution to a discussion before the International Geological Congress at Stockholm relative to the available supply of iron ore.)
Leith, C. K., Iron-ore reserves: Econ. Geology, vol. 1, 1906, pp. 360–368.
Pumpelly, Raphael, Iron ores of the United States: Tenth Census U. S., vol. 15, Mining industries, 1880. (Benton, E. R., and Willis, Bailey, Notes on samples.)
Putnam, B. T. and Chauvenet, U. M., Notes on samples of iron ore collected for analysis and on the ore deposits from which they were taken: Tenth Census U. S., vol. 15, Mining industries, 1880.
Swank, J. M., American iron trade: Mineral Resources U. S., annual volumes, 1882 to 1904, inclusive; also annual statistical reports of the American Iron and Steel Association, Philadelphia.
——— Iron and steel and allied industries in all countries: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 5, 1896, pp. 51–140.
Geologic Atlas of the United States, folios which contain sections on iron ores:[a] Nos. *2*, *4*, 5, *6*, *8*, *10*, 11, 12, 14 18, *19*, 20, 21, 22, 24, 25, 28, *32*, *33*, *35*, 36, 37, 40, 43, 44, 55, 56, 59, 61, *62*, *64*, 70, 72, *78*, 82, 83, 84, 90, *91*, 95, 101, 115, 116, 118, 120, 121, 124, 125, 126, 129, 135, 138, 139, 143, *151*, *157*, *161*, *170*, 171, 174, *175*, 178, 179.

[a] Numbers of folios containing important notes on iron ores are printed in italics.

# IRON-ORE RESERVES OF MICHIGAN.

By C. K. Leith.

## INTRODUCTION.

Early in 1911 the Michigan Legislature directed the State Board of Tax Commissioners to appraise the value of the mining properties of

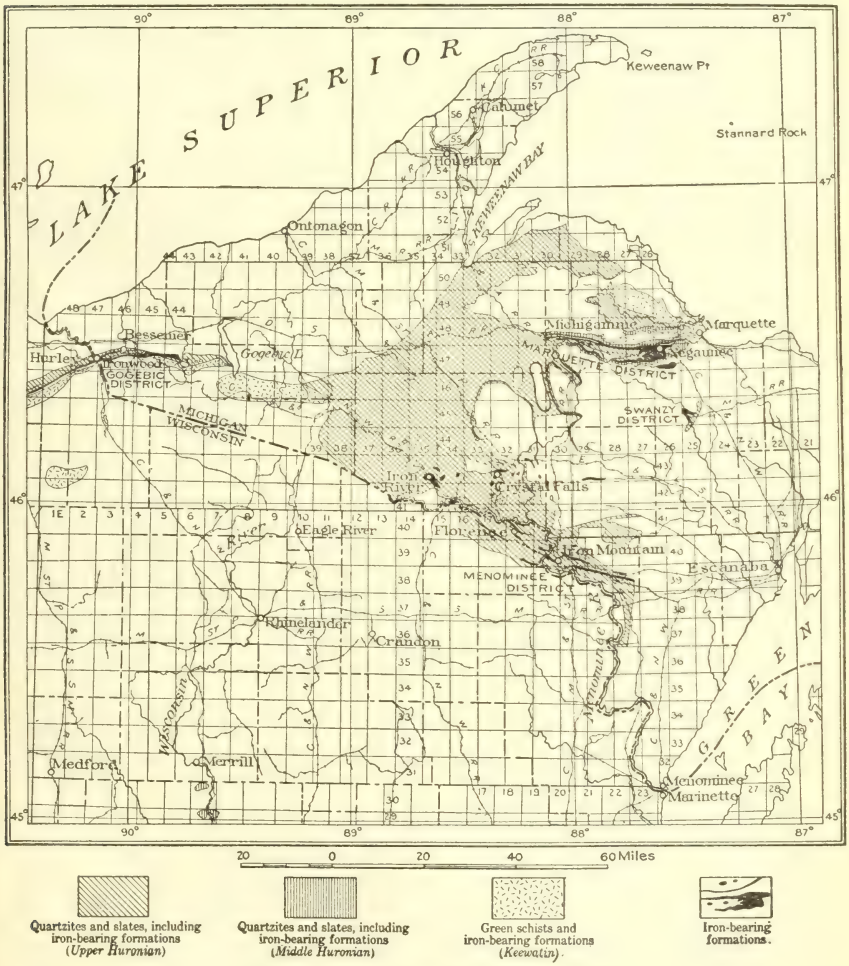



FIGURE 4.—Iron-ore reserves of Michigan in 1911.

Michigan as a basis for taxation and appropriated a sum of money for that purpose. Mr. J. R. Finlay of New York was appointed appraiser by the tax commission. The writer was asked to estimate

the iron-ore reserves, and his estimates were used without substantial modification in the final valuation by the tax commission. His report was not published by the tax commission except as it was quoted in Mr. Finlay's report on appraisal. It would not be desirable to publish the full report, for it contains detailed accounts of the reserves of each mine, but the Michigan Tax Commission has granted permission to publish the summary which is here presented. It is believed that this summary may be of general interest, as it not only shows approximately the physical condition of the ore reserves on August 1, 1911, but indicates the method of estimate and its relations to geologic inference.

Only two months were available for the work of collecting and compiling the data, so that more detailed results could not be obtained and the estimates probably include minor errors. It is believed, however, that the report gives a comprehensive and reasonably accurate account of the Michigan iron-ore reserves. At any rate, it is the first estimate of them that has been attempted.

## MICHIGAN IRON-ORE SITUATION.

A broad survey of the Michigan iron-ore situation brings out certain salient facts tabulated below, which are of significance in estimating the ore reserve.

*Michigan iron-ore reserves, by districts.*[a]

| District. | Total area of ore in bottom levels of active mines. | Area of ore developed by drills; vertical projection to surface.[b] | Total area of iron ore in Michigan. | Reserve in mines. |
|---|---|---|---|---|
| | *Sq. feet.* | *Sq. feet.* | *Sq. feet.* | *Long tons.* |
| Menominee | 263,465 | ..... | 263,465 | 11,650,450 |
| Crystal Falls | 209,730 | 167,000 | 376,730 | 3,682,142 |
| Iron River | 1,065,000 | 984,000 | 2,049,000 | 18,297,700 |
| Gogebic | 694,000 | None. | 694,000 | 31,605,000 |
| Swanzy | ..... | 3,298,000 | 3,298,000 | 2,712,737 |
| Soft ore or "hematite," Marquette | 1,045,000 | 7,497,740 | 8,542,740 | 37,516,800 |
| Hard-ore mines top of Negaunee formation, Marquette. | 350,000 | 841,065 | 1,191,065 | 17,391,335 |
| Mines west of Michigamme | 99,000 | 211,600 | 310,600 | 1,742,000 |
| Total | 3,726,195 | 12,999,405 | 16,725,600 | 124,598,164 |

| District. | Reserve in area drilled. | Total reserve. | Total shipment. | Average depth of active mines at lowest developed level. |
|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Feet.* |
| Menominee | ..... | 11,650,450 | 42,616,000 | 1,160 |
| Crystal Falls | 1,925,000 | 5,607,142 | 15,609,000 | 1,070 |
| Iron River | 9,719,000 | 28,016,700 | 6,179,300 | 445 |
| Gogebic | None. | 31,605,000 | 55,027,691 | 1,400 |
| Swanzy | 4,138,738 | 6,851,475 | 2,420,232 | |
| Soft ore or "hematite," Marquette | 25,929,000 | 63,445,800 | ..... | c 690 |
| Hard-ore mines, top of Negaunee formation, Marquette. | 2,939,200 | 20,330,535 | 96,296,717 | c 1,041 |
| Mines west of Michigamme | 332,000 | 2,074,000 | 1,080,000 | c 220 |
| Total | 44,982,938 | 169,581,102 | 219,228,940 | ..... |

a Low-phosphorus, high-silica mines not tabulated.

b The phrase "vertical projection to surface" signifies that the area of dipping and pitching ore bodies is stated in terms of horizontal measurement at the surface—that is, that the structure has been flattened out in making computations.

c Not rated according to tonnage of outputs.

One of the most significant features of this table is a comparison of fully developed bottom areas of ore by mines and districts. Only areas that give promise of continuity below have been tabulated. Exhausted or nearly exhausted mines are assigned bottom areas of zero. These figures are not strictly comparable throughout; in other words, each area does not have the same promise of continuity in depth. The notably large size of the areas of the Marquette ores is due partly to the low dip and pitch of the soft-ore bodies which give them great horizontal and small vertical dimensions. Such ore bodies signify future probable development not below but laterally, in the direction of pitch or dip.

Area of ore shown by drilling is not directly comparable to area of ore shown in present bottom-developed levels, for the reason that the drills may cut the ore at many levels, whereas the bottom-mine areas cut the ore at a single level.

If the mined-out portions of the ore bodies lying lateral to the levels estimated were projected to the surface, they would add an area to the area of the present fully developed bottom levels, which would make it more comparable with the area shown by drilling. The aggregate area of ore cut by drilling has been given only to afford a convenient comparison of the exploration in the different districts.

The table assigns no areas nor tonnage to high-silica, low-phosphorus ores of about 40 per cent grade, which have been mined on both the Gogebic and the Marquette ranges. These lean ores are so abundant and grade so imperceptibly into iron formation that no estimate of their tonnage or area has been attempted. In considering the table, however, they should be taken into account as adding a considerable reserve, which would tend to bring the total ascertained reserve more nearly to the present total shipment from the region.

The probabilities of extension in every district but the Menominee are so strong that it is safe to estimate that for many years the ratio of reserve to total shipment will be maintained—in other words, that as much ore will be discovered yearly as is mined yearly. In fact, to-day the reserve probably bears a larger ratio to the total shipment than at any time in the past, and the possibilities of developing more ore are so great that 10 years from now there will probably be greater reserve in proportion to shipment than now. The increasing tendency of the larger interests to make sure their ore supply for years in advance is leading to the development of increasingly large reserves in proportion to past shipment. Enough facts might be cited in relation to individual mines, explorations, and ranges to show that this forecast of the future is not based on vague surmise. Large extensions, both vertical and areal, are inevitable. Probably not more than 10 per cent of the area of the upper Huronian slates of the Crystal Falls, Menominee, Iron River, and adjacent areas has been explored. Iron formation lenses are likely to be found almost anywhere in these slates. The heavy drift covering will make their discovery a slow and costly process.

The total known area of iron formation is 29,267 acres. In addition, there are fully 20,000 acres of magnetic belt in which explora-

tion has scarcely more than begun. Probably half of this total acreage is iron formation of grade and character that will afford workable bodies of iron ore. The total area of iron ore in Michigan projected vertically to the surface is at present known to be at least 383 acres, or 1.31 per cent of the area of total known iron formation. This area does not include many abandoned mines or worked out portions of mines that lie lateral to present surfaces of ore. If these were taken into account, the total surface area of vertical projection of all ore bodies, present and past, would be considerably larger. Future discoveries are certain to increase this area still further. Therefore the average chance of finding ore in iron formation is larger by a considerable but at present unknown ratio than the percentage 1.31 given above. This figure does not necessarily indicate that only 1.31 per cent of the 40-acre tracts carry ore, for the ore is so distributed that it includes or touches a much larger proportion of the tracts.

The conclusion therefore is that at no time in the past has the outlook for long life for Michigan iron ores been any better assured than it is now. There are few regions in which expenditures of money for large explorations can yield more certain results. The future size of the reserve will be in more or less direct ratio to the money expended in exploration. There is yet no indication of diminishing returns from exploration. In fact, increased knowledge of the geologic conditions is bringing more certain results for a given expenditure of money. The reserve will cease to grow only when difficulties of exploration or outside economic influences begin to limit the amount of exploration.

This table shows the essential relative standing of the different ranges. The Marquette stands easily first in present tonnage and in future promise. The Iron River and the Gogebic are in nearly the same rank so far as present tonnage is concerned. The Menominee district has evidently seen its best days.

The present estimates of probable ore are limited by certain conventions, described elsewhere, which bring the total reserve to a figure below the total past shipment of iron ore from Michigan. There can be no reasonable doubt, however, that the reserve of iron ore, developed and probably available, approximates the total past shipment. This statement is true for all the ranges except the Menominee, and the shortage in the Menominee is more than offset by the great promise of the adjacent Crystal Falls and Iron River districts.

## METHODS USED IN MAKING ESTIMATES.

### MINES.

Most of the estimates received from the mines cover ore actually developed above the bottom levels. Some include, as probable ore, the extensions of partly developed levels. One company adds as probable ore an arbitrary unit of 2,000 tons where the breast of the drift is in ore. Others have added as probable ore all the ground from 10 to 200 feet below the bottom level, where the continuity

of the deposits above and the geologic conditions indicate that the ore is likely to have somewhat the same persistence below that it has above. Where drill holes have shown ore that lies in advance of or below present workings and undoubtedly in the extension of the same deposit, the estimate of probable ore has been extended to include these holes.

It is obvious that if the estimates turned in were accepted as they stand, the reserves would not be treated in the same manner throughout, and that companies which used the more liberal methods of estimating would be at a disadvantage as compared with other companies. It has, therefore, been found desirable to formulate a convention to be applied, so far as seems reasonable, to all estimates. The convention is this: Estimates of developed ore are practically accepted as turned in. Estimates of probable ore are modified to include for each mine at least one full level below present workings, with area equivalent to the average of the lowest fully developed levels. Also, partly developed levels are extended to the dimensions of the nearest fully developed levels. Where drill holes show ore in advance or below and within reasonable distance of the workings, this ore is added. Where the ore body is actually exhausted or the geologic conditions show a strong probability of the exhaustion or narrowing of the ore body below, this convention has been modified accordingly. In applying this convention to each property there have been taken into consideration the total shipment of the mine, the persistence of the ore body, the depth, the comparison of the areas of the lower levels with the average of the levels above, and the geologic conditions. It is possible that this method of estimate gives to a few properties a little more ore than the mining company is willing to concede as a part of its probable reserve, but it is believed that these properties are extremely few; in fact, none are known. For most properties the probability is that the ore body is really much more extensive than has been estimated.

### PROBABLE ORE SHOWN BY DRILLING.

Ore cut by drilling has been treated in a still more varied fashion in the estimates received. Certain companies have merely turned in records of drill holes without attempting to estimate the ore. Others have turned in a lump estimate—generally moderate. Others have given an estimate of the ore within a radius ranging from 25 to 100 feet of each hole, and have made no attempt to connect holes. Others have drawn around each hole a circle having a radius of 50 to 100 feet, according to the thickness of the ore cut in the hole, and have then connected by straight lines the peripheries of the circles drawn around adjacent holes on the assumption that ore lies continuously between them. Others have treated the holes as means of showing cross sections of a continuous ore body and have connected the ore between sections, making no allowance for extensions beyond limiting holes. Still others have allowed extensions of 50 feet beyond limiting holes. One company estimates its extensions beyond limiting holes to the point of a triangle distant one-third of the thickness of the ore shown in these limiting holes.

The possible variation in reasonable inference from drill holes is clearly much greater than that from mine workings. It has not been found desirable to use the same convention throughout in estimating from drill holes, but the geologic conditions and the probabilities of connection of ore shown in different areas have been considered in determining a reasonable method of estimate for each property. Where the proximity of the holes to one another and the geologic conditions indicate a reasonable certainty of continuous ore between holes, the limiting holes have been connected by straight lines and the area between them has been rated as showing a thickness of ore equal to the average of that cut by the adjoining holes. Allowance is made for irregular spacing of holes in estimating average thickness. Where the ore body has a steep dip or where holes cut it at an angle, due allowance is also made. Where the holes are so scattered that it seems unsafe to connect the holes through so large an area, they have been connected in small groups and the area is estimated in the same fashion. As a rule, no allowance has been made for ore estimated by the companies to extend beyond limiting holes, and these exclusions should counterbalance possible errors made by including too large areas between holes. Where the holes are so distributed in linear fashion as to make it difficult to connect the corresponding areas, the method used by certain companies has generally been followed. This method gives the limiting holes a radius up to 75 feet, according to the thickness of the ore cut in the hole, and then connects by straight lines the peripheries of the circles of the limiting holes so circumscribed.

Of course, no possible method will bring the estimates of drilling to a single standard or degree of probability, for the geologic conditions shown by the different ore bodies are extremely diverse. The method used, however, is so conservative that it can do no property substantial injustice, and it is practically certain that in most localities the quantity of ore present is far greater than that shown by the estimates.

### DEDUCTION FOR MINING LOSS AND ROCK.

Certain companies have made uniform deductions of 20 per cent for mining loss and rock in their estimates and have reported only the available ore in their reserves. For certain localities, where the nature or location of the surface is adverse, still greater deductions have been made. Other companies, and these include the majority, made no deduction for mining loss and rock. The variation in estimates due to differing treatment of these losses is not so great, especially between similar properties, as the difference in the treatment of these losses by different mining companies would indicate. It is probable that some of the company estimates make allowance for these losses even though it is not so stated. The estimates are made in so many ways and the variations in other features have been so great that in making deductions for mining loss and rock, each of the companies has been considered individually. In general, the estimates made from drilling are reduced

### NUMBER OF CUBIC FEET PER TON USED IN ESTIMATES.

The estimates turned in range from 7 to 18 cubic feet of ore per ton, the figure depending on the grade and texture of the ore, on varying judgment as to the right figure, and on conventions which certain of the companies have arbitrarily used for all their ores. One company computed 18 cubic feet of ore per ton; another company, mining almost exactly the same kind of ore, computed 10 cubic feet. Careful tests of the cubic contents of the ores from the different grades and textures have been made by the Oliver Co., the Cleveland Cliffs Co., and others. They show an average of 8 cubic feet per ton for the hard ores, 12 cubic feet for the soft ores, and 13 or 14 cubic feet for low-grade ores. The Oliver Co. used 10 cubic feet per ton throughout in its estimates as a convenient convention, on the assumption that the error in this figure is considerably less than the error in the assumptions as to dimensions of ore bodies. The figures taken as a standard for each district seem to correspond to the average usage for that district. These figures are as follows:

*Cubic feet per ton of iron ores of Michigan.*

| | |
|---|---|
| Marquette hard ores | 8 |
| Menominee ores and Gogebic ores | 10 |
| Soft ores of the Marquette, Crystal Falls, and Iron River districts | 12 |
| Low-grade high-silica ores | 14 |

Company estimates have not been recalculated to this basis, unless the figure used by the company is considerably too large or too small. It has seemed desirable to allow some variation in this regard, for the operators of most of the companies have formed a pretty definite idea how their ore has run, and even for mines whose figure is probably 1 or 2 cubic feet per ton larger or smaller than it should be, this error is offset by larger errors in assumptions as to dimensions or in deductions for rock or mining loss.

### TIME AT WHICH ESTIMATES WERE MADE BY COMPANIES.

Because of difference in time in making their own annual estimates, or because their records are not up to date, and because in part of misunderstanding, the companies have dated their estimates all the way from January 1 to July 1, 1911. The reports have been so late in coming in that it has not been possible to revise them to a uniform date, but this fact has been taken into consideration in making the estimates. To illustrate, one company may have turned in its estimates since January 1, 1911, but, on the other hand, its method of making estimates from drill data may be so liberal as to compensate for the omission of late discoveries.

### COMPARISON OF ESTIMATES BY APPRAISER AND BY COMPANIES.

The appraiser's estimate has added 25 per cent to the total tonnage reported by the mining companies. This was the net result of the use of all the factors mentioned.

## CLASSIFICATION AND DISTRIBUTION OF IRON LANDS.

The following table shows the distribution by counties of the known iron formation and magnetic belts, measured by 40-acre tracts and also calculated from planimeter measurements. In these 40-acre tracts an area about twice as large as the actual iron land is included. The iron lands are roughly grouped in classes. Lands of class A are known to be favorably located for exploration; in lands of class B the geologic conditions are doubtful, but the lands will probably be explored more or less in the future; lands of class C are magnetic belts or lands of lean or unfavorable iron formation, in which the chances for ore are remote or entirely unknown.

*Classification and distinction of iron lands in Michigan by counties, in acres.*

| County. | Measured by 40-acre tracts. | | | | Determined by actual planimeter measurement of areas. | | |
|---|---|---|---|---|---|---|---|
| | Class A. | Class B. | Class C. | Total. | Iron formation. | Magnetic belt. | Total iron formation and magnetic belt. |
| Dickinson | 11,040 | 4,000 | 6,440 | 21,480 | 4,226 | 3,095 | 7,321 |
| Marquette | 34,960 | 8,880 | ..... | 43,840 | 16,810 | 2,847 | 19,657 |
| Gogebic | 6,720 | 1,720 | 2,320 | 10,760 | 5,449 | 496 | 5,945 |
| Iron | 11,040 | 10,760 | 4,840 | 26,640 | 1,972 | 12,702 | 14,674 |
| Baraga | 3,160 | ..... | ..... | 3,160 | 810 | 1,841 | 2,651 |
| Total | 66,920 | 25,360 | 13,600 | 105,880 | 29,267 | 20,981 | 50,248 |

## THE GOGEBIC DISTRICT.

A part of the iron ores of the Gogebic district occurs in tabular bodies that lie parallel to the bedding and a part occurs in great widenings of these bodies at the intersection of dikes with footwall quartzite or slate. The line of intersection of the dikes with the footwalls in general pitches to the east, although in some places the pitch is to the west and in others this line is horizontal. It was formerly supposed that the upper dikes limited the ore bodies below, but it is now known that the ore bodies may be repeated on dike below dike, and to-day no one is willing to predict the depth to which this repetition may be carried. The ore body at the intersection of dike and footwall on one property may pitch on another property at considerable depth and may go still beyond to depths not yet touched by exploration.

The total area of fully developed bottom levels in the district is 876,000 square feet. This estimate, however, must be modified before it can be used in forecasting the future production of the district, for ore bodies pitch from one property to another, and therefore, in adding the bottom levels of the two properties, what is really a single ore body is considered twice—as, for instance, in the Pabst and the Newport bottom areas. In estimating the future output of the district the largest deductions to be made are those arising from duplication of areas in the Pabst and Newport and in the Pabst and

Aurora ore bodies, which are probably the same ore shoot. Deduction for these ore bodies will give a total area for the district of 694,000 square feet. The areas of bottom levels of other mines probably include some duplication, but this is not nearly so certain, and they are so far separated as to allow for each mine a considerable projection below.

It is estimated that the total area of ore in all average levels is to the total area of ore of all present bottom levels as 100 is to 118. If old mines that have been exhausted or abandoned are included in the estimate, the total area of the present bottom level is 5 per cent greater than the average total area of upper levels.

The total shipment from the Michigan portion of the district has been 55,027,691 long tons. The total reserve is 17,298,000 long tons above bottom levels and 14,307,000 tons more below, or 31,605,000 tons of reserve in all. Drilling has disclosed not many new ore bodies in this district, and the reserve for the mines covers practically all the known reserve. At the present rate of shipment—3,664,594 tons in 1910—this reserve will last about 8.6 years, but further extensions are probable. The average depth of the lowest developed level, rated according to output, is 1,400 feet.

It is obvious that possible further extensions of ore bodies in depth—extensions not here considered—may necessitate a great increase in the estimated quantity of available reserves. It has recently been discovered that the ore bodies in the hanging-wall slates are much more extensive than had been suspected, and the possible development at this horizon is large.

## THE IRON RIVER DISTRICT.

The ores of the Iron River district occur in closely folded upper Huronian slates. The iron formation lenses in which the ores occur are uniformly of steep dip. In a large way they have a distinct linear trend, but almost every lens shows major and minor buckles and considerable widening or narrowing of the formation. The walls of the ore body may be all slate, all jasper, or any combination of the two. The larger ore bodies occur in places where the formation has been thickened by folding. The axes of these folds are favorable places for the concentration of ore. They have steep pitch and the ore bodies they contain should have great persistence in depth—in fact, underground development and drilling have already shown that they extend to great depths. As would be expected under these conditions, individual ore bodies are extremely irregular in outline, though in a large way they may conform to the major trend of the district. The principal ore zone of the district is contiguous to the valley of Iron River, extending from the Zimmerman mine northward to the town of Iron River. From this valley the ore-bearing zone sends a branch northeastward through the Baker-Tully, Blair, Munro, and Erickson mines, and possibly thence to the Chicagoan mine. Another and as yet independent area runs east and west through the Osana, Davidson, and Bates properties, which lie north of the Iron River. Throughout these areas nearly every 40-acre tract that carries iron formation shows some ore. The underground developments are shallow; the deepest mine is 690 feet

deep and the average depth is about 445 feet, but drilling has shown that the ore goes down to 1,712 feet.

The total area of the bottom levels of the mines which have not been exhausted or abandoned is 1,065,000 square feet. The average depth of these bottom levels, rated according to tonnage of ore taken out above them, is 445 feet. The total shipment from these mines has been 6,179,300 tons and the reserve reported above the lowest levels is about 8,668,700 tons, so that the total ore taken out or left above these levels is 14,848,000 tons. As the cubic measure of this ore and its average depth are known, it may be calculated, due allowance being made for overburden, that the average ore areas of the levels above the present bottom levels have been smaller than the ore areas of the present bottom levels by 55 per cent.

These figures do not closely apply to any one property for the reason that they include new ore bodies from which the past shipment has been small. Correction can be made for this factor by rating the present bottom areas in proportion to the ore shipped from above them. The figures given apply only to those mines that have shipped 87 per cent of the total output of the district. The remaining 13 per cent of the output has come from mines that have been exhausted and abandoned. When corrections have been made for these mines it appears that the average levels for all mines that have shipped ore are 63 per cent smaller than the present lower levels. Although geologic conditions make it necessary to consider each mine separately, this general average gives a reasonable expectation for the yield of the district as a whole, to which the yield of individual mines may be expected to approximate.

If the mines maintain their present bottom levels to the depth of the deepest developed level in the district—690 feet—180 feet (probably too much) being allowed for drift, the output to be expected will be 30,242,250 tons. If the mines maintain their area to the greatest depth shown by drilling—1,712 feet—the total output for the district will be 112,500,000 tons. If the mines be supposed to come to a point at the greatest depth shown by drilling, their yield will be 56,223,000 tons.

These approximations are based principally on developed or partly developed mines. Extensive explorations by drilling show an additional minimum area of 984,000 square feet of ore. This is the area of ore projected to the surface, and a moderate estimate of the ore it represents is 9,719,000 tons. Although some of the older mines may soon become exhausted, their exhaustion will be much more than offset by the development of ore bodies now known only by drilling, so that for some years to come the total area of known iron ore in this district will increase rather than decrease.

A comparison of the total area of ore disclosed in this district by underground development and by drilling with that in other Michigan ore districts, shows that the Iron River district ranks next below the Gogebic in quantity of available ore. On the other hand, it is at a disadvantage as compared with the Menominee, Gogebic, and Marquette districts, in that its ore is, on the whole, of lower grade and less desirable.

The total shipment from this district thus far has been 6,179,300 tons. The reserve reported from mines above lowest level is 8,668,700

tons, the reserve estimated below the lowest levels is 9,629,000 tons, and that estimated from exploration is 9,719,000 tons, a total reserve of 28,016,700 tons. At the present rate of production, if no more ore is discovered, the district can be counted on to produce from known ore bodies for about 22 years. However, when we remember how small a portion of the area has been explored and the enormous possibilities of extension of these ores in depth, it appears that the life of the district will be indefinitely extended.

## THE CRYSTAL FALLS DISTRICT.

The ores in the Crystal Falls district are in upper Huronian slates (Michigamme) except the ore of the Mansfield mine, which is in a band of slates in the Hemlock formation (basic volcanic), and the Groveland mine, which lies at the base of the upper Huronian. In the Crystal Falls district, as in the Iron River district, the iron formation lenses are steeply tilted, much folded, and show great variation in thickness. The walls may be slate or jasper or any combination of the two. The larger ore bodies occur in folds in the iron formation which have thickened the formation. The pitch of these folds has considerable persistence in depth. Nearly every 40-acre tract in the producing part of the district that carries iron formation contains some iron ore.

The total bottom area of mines that have not been exhausted or abandoned is 209,730 square feet. The average depth of these levels, rated according to tonnage, is 1,070 feet. The total shipment from these mines and the reserve still left above the bottom levels aggregate 17,266,142 tons, of which 1,925,000 tons is reserve above the lowest developed level. If the cubic measure per ton of the ore included in this total of shipment and reserve is estimated at 12 cubic feet, and the product is divided by the average depth, it appears that the average area in the past has been 195,700 square feet. The total bottom area includes some areas from which little ore has been shipped and does not include some areas from which ore has been shipped from exhausted or abandoned mines. After introducing corrections by rating areas according to tonnage shipped, it appears that for the average mine the present bottom level is about the same as the average of the levels above. This fact should have some application to individual mines, although geologic conditions require the separate consideration of each property.

In addition to the ore shown by mines, 167,000 square feet of ore are shown by drilling, which at a moderate estimate should yield 1,412,000 tons. The 167,000 square feet is the area of drilled ore bodies projected to the surface. As the old mines become exhausted these ores will come in to maintain the reserve of the district. The total shipment of the district has been 15,609,000 tons; the total reserve now in sight from mining and drilling is 5,607,142 tons. At the present rate of production the life of the district would be 4.05 years, if no more ore were discovered, but future discoveries by drilling may disclose much more ore, for only a small percentage of the upper Huronian slates has been drilled.

If the mines maintain continuous production at their present levels and carry these levels to a depth equal to that of the Dunn, the deepest mine now worked in the district, the reserve between this depth (1,327 feet) and the average level (1,070 feet) would be 4,475,000 tons.

## THE MENOMINEE DISTRICT.

The total area of ore on fully developed bottom levels of the Menominee district, in which the ore is not known to be cut off by rock or to pitch off the property within a limited distance, is 263,465 square feet. The average depth of these bottom levels, rated according to quantity of ore that has been shipped from the mine, is 1,160 feet. If the ore shown in bottom levels continues with present areas to the depth of the deepest known ore, the probable ore in the district would be 6,320,000 tons. However, if the total area of the lowest levels is 263,465 square feet, if the average depth of these levels is 1,160 feet, and if the total ore shipped from mines not yet bottomed and in reserve above this average level is 41,000,000 tons, it may be calculated that the average area of levels above present bottom levels has been 354,900 square feet, or 34 per cent greater than present bottom levels. These figures are derived from a consideration of mines that have made 80 per cent of the total shipments. The remaining 20 per cent of the shipments came principally from mines like the Pewabic, which is bottomed. On correcting for such mines it appears that the average upper levels have been 36 per cent greater than the present bottom levels. These facts indicate a diminution of total area with depth for the district as a whole, which would prevent the assumption that the ores below present bottom levels will maintain the same total area below. If the total area decreases below in the same ratio that it has decreased from the surface down, the probable quantity of ore lying between present bottom levels and present maximum depth would be about 5,770,000 tons. The total reserve above bottom levels is 9,083,450 tons, the total below is 2,567,000 tons, and the total for both is 11,650,450 tons. The total shipment for the mines considered is 42,616,000 tons.

A part of the ore occurs in tabular bodies parallel to the bedding and a part in more or less well-developed pitching folds bottomed by dolomite, talc, schist, or slate, and the ore deposits in these folds are therefore elongated in the direction of the pitch. The degree to which the ore is confined to these pitches varies in different mines and in different parts of the same mine, the pitches being less well developed near the surface than below. The folds unquestionably pitch a long distance below the present bottom levels, and there seems to be nothing in the character of the rock or its alterations or other features at the bottom levels to show why the ore, at least that in shallower mines, should not continue on these pitches to as great a distance below the surface as that which has been reached by the deepest mines in the district, and probably to even greater depths.

## THE MARQUETTE DISTRICT.

### KINDS AND QUANTITY OF ORE.

The ores of the Marquette district occur in several grades and under diverse structural conditions, and they will therefore be considered in separate groups, as follows: (1) The soft ore of the mines of the upper Huronian slates east of Michigamme; (2) the ore of the mines west of Michigamme; (3) the hard ore of the mines at the top of the Negaunee formation; (4) the soft ore of the "hematite" mines within the Negaunee or near its base, principally in the vicinity of Negaunee and Ishpeming; (5) Swanzy; (6) the hard, siliceous, low-phosphorus ores from the Marquette and Menominee districts.

The total area of the bottom levels of the mines of the entire Marquette district, exclusive of the Swanzy, which have not been exhausted or abandoned, is 1,494,000 square feet. The reserves of the mines are 59,362,872 tons. In this district, including the Swanzy, there have been extensive explorations by drilling, the results of which when added show a total area in ore of about 13,342,405 square feet. The large size of this drilled area is due partly to low dip—it is the area of the ore projected to the surface, and a moderate estimate fixes the quantity of the ore at 33,338,938 tons. This estimate is obtained after deducting 20 per cent for mining loss.

A comparison of the total area of ore disclosed in this district by underground development and by drilling with that in other Michigan ore districts shows that the Marquette district ranks first in available resources of iron ores.

### SOFT ORES IN THE UPPER HURONIAN SLATES EAST OF MICHIGAMME.

A group of mines in the upper slate area—the Bessie, the Phoenix, the Northampton, and others—has produced a low-grade limonite in small quantities. The total shipments from this group have aggregated 118,200 tons. The ores are very much folded. The ore bodies are small and irregular, and the chance of profitable operation does not seem to be good. All these mines have been closed down for some time.

### ORES OF MINES WEST OF MICHIGAMME.

A group of mines have been recently developed in the upper Huronian rocks, south of the quartzite. In general, these have a monoclinal dip to the south and promise considerable extension in depth. The total area of fully developed bottom levels here is 99,000 square feet.

The average depth of producing mines, not rated according to tonnage, is 220 feet. The shipment from these mines has aggregated 1,080,000 tons. Drilling has shown considerable extensions of the ore on the Imperial mine. The reserves of the mines in this district are 1,742,000 tons.

Explorations by drilling in this district show an area in ore projected to the surface of about 211,600 square feet, or 332,000 tons,

after a deduction of 20 per cent for mining loss and rock. The ore is soft, low-grade hematite, which is estimated at 14 cubic feet per ton.

### HARD ORE MINED AT THE TOP OF THE NEGAUNEE FORMATION.

The ores at the top of the Negaunee formation, just beneath the Goodrich quartzite, are in general hard hematites, locally more or less specular and magnetic. In certain of the mines the basal conglomerate of the upper Huronian, which rests against these ores, is also sufficiently rich in ore to be mined and constitutes a part of the ore bodies. The ore bodies are tabular in shape and lie parallel to a steeply dipping contact of the Negaunee and the Goodrich quartzite, though they are locally folded and faulted. Some of them show a lateral pitch in the plane of contact. Soft hematite is locally found in these mines in the jasper footwall. In Section 16 mine the hematite and the hard ore have come together on the bottom level, and the soft ore is becoming relatively more abundant.

The aggregate of bottom levels of such of these mines as have not been exhausted is 350,000 square feet. The average depth of producing mines, not rated according to tonnage, is 1,041 feet. These ores have been mined to a depth of 1,984 feet at Champion, and this group of mines as a whole constitutes the deepest of the Marquette mines. The persistence of these ore bodies to the present levels affords good promise for still further persistence in depth. The reserves of the mines in this district are 17,391,335 tons.

Drilling at several points, notably under the city of Ishpeming and in the North Lake area, has shown additional ore not yet opened by mining. The estimated quantity of ore disclosed by this drilling is 2,939,200 tons.

It underlies an area of approximately 841,065 square feet. Further profitable explorations at this horizon are still possible. It is clear, therefore, that the hard-ore production may be expected to continue at the present rate for many years.

### SOFT ORE OF THE "HEMATITE" MINES.

The mines working on the soft "hematite" ore are located within the Negaunee formation in beds at its middle and lower horizons. Ordinarily they are not connected with the hard-ore deposits at the horizon at the top of the Negaunee, but in Section 16 mine ores of the two types come together. The soft ores are, as their name indicates, soft in texture, are somewhat more hydrous than the hard ores, and will run about 12 cubic feet to the ton. The ore bodies show great variety of shape. In the Negaunee Basin the ore body is a gently folded and faulted sheet having a comparatively low pitch to the south of west. In the Prince of Wales, Breitung No. 2, Mary Charlotte, Rolling Mill, and Cambria-Hartford areas the tabular development is much less marked, the ore occurring in more or less shallow channel-like runs in jasper. The ore bodies have relatively low pitch and great local irregularities and are cut by dikes. In the Lake Angeline area the ores lie in sharp troughs in greenstone. The bottoms of these troughs have relatively low pitch.

The average depth of the producing mines is 690 feet. This figure is not determined by rating depths of individual mines in proportion to content of ore, and therefore is not so accurate as the figures showing the depths of mines in other districts. The aggregate shipment of ore of this class has not been calculated, many of the older records being faulty.

The aggregate total area of bottom levels of the mines of this group is about 1,045,000 square feet, but as the ore bodies have in general a low pitch this aggregate area can not be fairly compared with the areas of the hard-ore mines in this district, or with the areas of ores in the Menominee, Crystal Falls, Iron River, and Gogebic districts, where the pitch is steeper or where the vertical element is dominant. The area of a section across the pitch would be more closely correlative. The projection of present bottom levels downward along the pitch would carry some of the flat-lying deposits off the property. It is apparent that owing to flatness of pitch the areas or cross sections in many adjacent properties are duplicated, the same ore body running through both properties and being cut at different elevations. So far as data have been available the estimate for total area has been corrected by subtracting for duplication or by making allowance for the flatness of the pitch. The area, 750,000 square feet, represents approximately the same kind of promise for the ground below the present bottom levels in this group of mines that would be represented by the aggregate bottom areas given for the other ranges. The reserves of the mines of this district are 37,516,800 tons.

Drilling to the soft-ore horizon has disclosed a vast amount of ore, which will not be exhausted for many years. This drilling has revealed most notable resources in the area bounded on the north and west by the Maas-Negaunee and Cambria mines and on the southeast by the Mary Charlotte and the Rolling Mill. Nearly every 40-acre tract in this area has either shown ore or lies in such relation to ore bodies discovered as to indicate strongly the probability that it contains ore. The ore has been cut to a maximum depth of 2,375 feet. The pitch is in general to the west or southwest, and no one can yet say what the limit in these directions will be. The estimated available ore shown by drilling is about 25,929,000 tons. It underlies an area of about 7,497,740 square feet The quantity of ore developed by drilling in this area will more than maintain the present shipment of the soft-ore mines for an indefinite period, and the probability of further discovery by drilling is so great that the reserve of this class of ores in the future may be far greater than it has been in the past.

### ORES OF THE SWANZY DISTRICT.

The Swanzy district, which lies southeast of the Marquette district, occupies an isolated canoe-shaped basin in upper Huronian rocks nearly if not quite surrounded by granites. The axis of the basin extends northwest-southeast, with minor cross folding. The dips are gentle, except where cross folded. The granite basement is irregular. The iron formation may rest directly upon granite basement or may be separated from it by arkose or graywacke. The overlying rock is slate. The ore is relatively thin at the horizon near the base of the iron formation. The ore bodies lie principally on the northeast

side of the basin and at the ends. One known ore body, the Stephenson, is on the west side of the basin. The ores occur in tabular deposits that have gentle pitch. They have been thoroughly explored by drilling, and the total tonnage of the basin is reasonably well estimated. The Cleveland Cliffs Co. has drilled 81 holes in ore. The total shipment from this basin has been 2,420,232 tons. The total available reserve determined from mining and drilling operations, after deductions have been made for non-recoverable ore, is 6,851,475 tons. The shipment from the district in 1910 was 552,597 tons. This district may, therefore, be expected to maintain its present rate of production for 12.4 years. The total area underlain by ore is at least 3,298,000 square feet. The average thickness of the ore, as shown by drilling, is 41.7 feet.

### HARD, SILICEOUS, LOW-PHOSPHORUS ORES OF THE MARQUETTE AND MENOMINEE DISTRICTS.

In the discussion of the ore reserves of the Menominee and Marquette districts no account was taken of a number of mines that produce ore of about 40 per cent grade, high in silica and low in phosphorus, used principally for mixtures. The iron content of these ores is but little greater than the average content of iron in the adjacent iron formation. They are mined in part by open cuts and by milling, and in part by underground workings. Their mining at any particular locality depends on conditions favorable for mining, on unusually low phosphorus content, on the possession of an assured market, and, as with the Pewabic and other mines, on the low cost of handling ore of this grade along with ores of higher grade which are being hoisted. So far as is known, most of the mines that have produced ore of this grade can produce it far in the future, and an estimate of the minable quantity of this ore would be of little significance. In the Palmer area, for instance, an estimate of the quantity of such ore would show enormous resources, but the limits of the ore are so indefinite that an estimate would be difficult. It should not be assumed, however, that unlimited quantities of these ores are available. It is true that there is an enormous quantity of ore carrying 40 per cent of metallic iron, but the areas where the phosphorus is exceptionally low and where the conditions allow cheap mining are comparatively small.

# MANGANESE AND MANGANIFEROUS ORES.

By Ernest F. Burchard.

## INTRODUCTION.

The present chapter treats of the statistics of production of both manganese ore and manganiferous ore in 1911, the latter ore including both manganiferous iron ore and manganiferous silver ore. The basis considered is marketed production, that is, the quantity sold or used by the producer during the year. In addition, statistics are given of the foreign trade in manganese ore and of the important alloys. In consideration of the continued interest that is shown by public inquiries in regard to the sources and use of manganese, sections on these subjects are reprinted from year to year.

The manganese industry in the United States was not characterized by any unusual features during the year 1911. There was a slight increase in production of domestic manganese ore and a decrease in that of manganiferous ore. There was also a decrease in the imports of manganese ore, these two decreases being due to depression in the iron and steel industries. In comparison with its status between the years 1884 and 1901 the domestic manganese industry to-day is at a low stage, and there are no immediate prospects for improvement. The importation of manganese ore continues greatly to exceed the quantity mined in this country and will probably so continue so long as the principal sources of foreign supply are abundant and cheaply worked and ocean freights are low.

## MANGANESE ORE.

### PRODUCTION.

According to reports received by the United States Geological Survey, the manganese-ore industry showed slightly greater activity in 1911 than in 1910. Manganese ore was mined in 1911 in California and Virginia, the output in Virginia being of the greater importance Arkansas, which was a producer in 1910, reported no production in 1911. In 1911 the quantity marketed amounted to 2,457 long tons, valued at $24,586, the price per ton averaging $10.01, as compared with 2,258 long tons, valued at $22,892, an average price per ton of $10.14, in 1910. In addition to the quantity shipped, a small quantity, amounting to 1,707 long tons, remained in stock at the mines at the end of the year.

The following table shows the quantity, value, and average price per ton of the manganese ore produced in the several States in 1909, 1910, and 1911:

*Production of manganese ore in the United States, 1909–1911, by States, in long tons.*

| State. | 1909 | | | 1910[a] | | | 1911[a] | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Average price per ton. | Quantity. | Value. | Average price per ton. | Quantity. | Value. | Average price per ton. |
| Arkansas | | | | (b) | (b) | | | | |
| California | (b) | (b) | | | | | (b) | (b) | |
| Tennessee | (b) | (b) | | | | | | | |
| Virginia | [c]1,544 | [c]$19,675 | $12.74 | [d]2,258 | [d]$22,892 | $10.14 | [e]2,457 | $24,586 | $10.01 |
| Total | 1,544 | 19,675 | 12.74 | 2,258 | 22,892 | 10.14 | 2,457 | 24,586 | 10.01 |

[a] Marketed production.
[b] Included with Virginia.
[c] Includes production of California and Tennessee.
[d] Includes production of Arkansas.
[e] Includes production of California.

The following table shows the total production of manganese ore in the United States, by States, as compiled from previous volumes of Mineral Resources. The production prior to 1880 is only approximate, but probably did not exceed 50,000 long tons. Since 1910 figures represent marketed production. The table shows Arkansas, Georgia, and Virginia as the principal producers, California as a fairly steady producer but only of small quantities, and the other States as producing small quantities of ore intermittently. Where there are less than three producers in a State in a given year the production of that State is included with that of another State. The table also shows the periods of comparatively large production followed invariably by marked declines; but the present decline, which shows little indication of being followed by a large increase in production in the near future, is by far the most serious of all.

*Production of manganese ore in the United States, 1838–1911, in long tons.*

| Year. | Alabama. | Arkansas. | California. | Georgia. | Indian Territory, Michigan, Missouri, Montana, and Nevada. | North Carolina. |
|---|---|---|---|---|---|---|
| 1838–1879 | | 410 | | | | |
| 1866–1879 | | | | 19,950 | | |
| 1867–1879 | | | 5,500 | | | |
| 1880 | | | | 1,800 | | |
| 1881 | | 100 | | 1,200 | | |
| 1882 | | 175 | | 1,000 | | |
| 1883 | | 400 | | | | |
| 1884 | | 800 | | | | |
| 1885 | | 1,483 | 200 | 2,580 | (Nev.) 200 | |
| 1886 | 75 | 3,316 | 100 | 6,041 | (Nev.) 30 | 14 |
| 1887 | | 5,651 | | 9,024 | | 14 |
| 1888 | | 4,312 | 1,500 | 5,568 | (Mich.) 100 | |
| 1889 | | 2,528 | 53 | 5,208 | (Nev.) 15 | 47 |
| 1890 | | 5,339 | 386 | 749 | (Nev.) 100 | 14 |
| 1891 | | 1,650 | 705 | 3,575 | (Ind.T.) 206 | |
| 1892 | | 6,708 | | 826 | | |
| 1893 | | 2,020 | 400 | 724 | | |
| 1894 | | 1,934 | 278 | 1,277 | | |

*Production of manganese ore in the United States, 1838–1911, in long tons*—Continued.

| Year. | Alabama. | Arkansas. | California. | Georgia. | Indian Territory, Michigan, Missouri, Montana, and Nevada. | North Carolina. |
|---|---|---|---|---|---|---|
| 1895 | | 2,991 | 525 | 3,856 | | |
| 1896 | | 3,421 | 284 | 4,085 | | 2 |
| 1897 | | 3,240 | 484 | 3,332 | (Mich.) 37 | |
| 1898 | 22 | 2,662 | 541 | 6,689 | | |
| 1899 | | 356 | 115 | 3,089 | (Mo.) 16 | 90 |
| 1900 | | 145 | 131 | 3,447 | (Mont.) 137 | |
| 1901 | 17 | 91 | 610 | 4,074 | (Mo.) 28 | |
| 1902 | | 82 | 846 | 3,500 | | |
| 1903 | | | 16 | 500 | | |
| 1904 | | | 60 | | | |
| 1905 | | | 1 | 150 | | |
| 1906 | | 62 | 1 | | | |
| 1907 | | | 100 | | | |
| 1908 | | | | | | |
| 1909 | | | (*a*) | | | |
| 1910 | | (*a*) | | | | |
| 1911 | | | (*a*) | | | |
| Total | 114 | 49,876 | 12,836 | 92,244 | 869 | 181 |

| Year. | Pennsylvania, South Carolina, and South Dakota. | Tennessee. | Utah and Vermont. | Virginia. | West Virginia and other States. | Total. |
|---|---|---|---|---|---|---|
| 1838–1879 | | | | | | 410 |
| 1866–1879 | | | | | | 19,950 |
| 1867–1879 | | | | 18,000 | | 23,500 |
| 1880 | | | | 3,661 | 300 | 5,761 |
| 1881 | | | | 3,295 | 300 | 4,895 |
| 1882 | | | | 2,982 | 375 | 4,532 |
| 1883 | | | | 5,355 | *b* 400 | 6,155 |
| 1884 | | | | 8,980 | *b* 400 | 10,180 |
| 1885 | | | | 18,745 | 50 | 23,258 |
| 1886 | | 50 | | 20,567 | | 30,193 |
| 1887 | | | | 19,835 | | 34,524 |
| 1888 | (Pa.) 22 | | | 17,646 | *c* 50 | 29,198 |
| 1889 | (S. C.) 124 | 30 | (Vt.) 1,576 | 14,616 | | 24,197 |
| 1890 | | | | 12,699 | | *d* 19,287 |
| 1891 | (S. Dak.) 19 | | (Vt.) 49 | 16,248 | | *d* 22,452 |
| 1892 | | | | 6,079 | | 13,613 |
| 1893 | | 482 | | 4,092 | | 7,718 |
| 1894 | | 922 | | 1,797 | (W. Va.) 100 | 6,308 |
| 1895 | (Pa.) 460 | | | 1,715 | | 9,547 |
| 1896 | (Pa.) 265 | | | 2,018 | (W. Va.) 13 | 10,088 |
| 1897 | (Pa.) 354 | 11 | | 3,650 | | 11,108 |
| 1898 | | 381 | | 5,662 | | 15,957 |
| 1899 | (Pa.) 12 | 19 | | 6,228 | (W. Va.) 10 | 9,935 |
| 1900 | | 30 | | 7,881 | | 11,771 |
| 1901 | | 400 | (Utah) 2,500 | 4,275 | | 11,995 |
| 1902 | (S. C.) 8 | | | 3,041 | | 7,477 |
| 1903 | (S. C.) 25 | | (Utah) 483 | 1,801 | | 2,825 |
| 1904 | | | (Utah) 32 | 3,054 | | 3,146 |
| 1905 | | 20 | | 3,947 | | 4,118 |
| 1906 | | 30 | (Utah) 800 | 6,028 | | 6,921 |
| 1907 | (S. C.) 800 | 100 | | 4,604 | | 5,604 |
| 1908 | | | | 6,144 | | 6,144 |
| 1909 | | (*a*) | | *e* 1,544 | | 1,544 |
| 1910 | | | | *f* 2,258 | | *g* 2,258 |
| 1911 | | | | *h* 2,457 | | *g* 2,457 |
| Total | 2,089 | 2,475 | 5,440 | 240,904 | 1,998 | 409,026 |

*a* Included with Virginia.
*b* Georgia and North Carolina.
*c* Nevada, North Carolina, South Carolina, Tennessee, and Vermont.
*d* Colorado production of 1890 and 1891, published formerly as manganese, is manganiferous ore and has been transferred to that table.
*e* Includes production of California and Tennessee.
*f* Includes production of Arkansas.
*g* Marketed production.
*h* Includes production of California.

## STOCK.

The following table shows the quantities of mined manganese ore on hand at the mines at the close of 1910 and 1911:

*Stock of manganese ore on hand at the mines on Dec. 31, 1910 and 1911, by States, in long tons.*

| State. | 1910 | 1911 |
|---|---|---|
| Arkansas | 100 | 200 |
| California | 116 | 102 |
| Utah | 20 | ..... |
| Virginia | 2,085 | 1,405 |
| Total | 2,321 | 1,707 |

## PRICES OF ORES.

The prices of domestic manganese ore used in the steel industry vary from $5 to $15 per long ton, according to the grade of the ore. They are governed by the following schedule of prices established by the Carnegie Steel Co.:[1]

Schedule of prices paid per ton of 2,240 pounds for domestic manganese ore delivered at Pittsburgh or Bessemer, Pa., and South Chicago, Ill.

Prices are based on ores containing not more than 8 per cent silica or 0.20 per cent phosphorus and are subject to deductions as follows: For each 1 per cent in excess of 8 per cent silica there shall be deduction of 15 cents per ton; fractions in proportion.

For each 0.02 per cent, or fraction thereof, in excess of 0.20 per cent phosphorus there shall be a deduction of 2 cents per unit of manganese per ton.

| Percentage of metallic manganese in ore. | Price per unit in cents. | |
|---|---|---|
| | Manganese. | Iron. |
| Over 49 | 26 | 5 |
| 46 to 49 | 25 | 5 |
| 43 to 46 | 24 | 5 |
| 40 to 43 | 23 | 5 |

Ores containing less than 40 per cent manganese or more than 12 per cent silica or 0.225 per cent phosphorus are subject to acceptance or refusal at the buyer's option.

Settlements are based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken being deducted from the weight.

The manganese ores for oxidizing and coloring purposes are valued according to the quantity of manganese peroxide present, their consistency, etc., and prices range up to $35 per ton for the better grades of ore. Manganiferous ores used in iron and steel manufacture and for fluxing range in price from $2 per ton upward.

[1] Prices of manganese ore: Eng. and Min. Jour., Mar. 5, 1910.

## IMPORTS.

The imports of manganese ore entered for consumption into the United States in the calendar year 1911 amounted to 176,852 long tons, valued at $1,186,791, as compared with 242,348 tons, valued at $1,711,131, imported in 1910, a decrease in quantity of 65,496 tons and in value of $524,340. The average price per ton of the imported manganese ore in 1911 was $6.71, as compared with $7.06 in 1910. The total imports for 1911 are the lowest for any year since 1905. As is shown in the table, the principal exporting countries are British India and Brazil, with important quantities imported from Russia, France, and Germany.

The following tables, compiled from data furnished by the Bureau of Statistics, Department of Commerce and Labor, show the imports of manganese ore into the United States from different countries and by ports of entry for 1909, 1910, and 1911:

*Imports of manganese ores into the United States, 1909–1911, by countries, in long tons.*

| Country. | 1909 | | 1910 | | 1911 | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Brazil | 35,600 | $323,743 | 53,750 | $544,353 | 41,600 | $342,769 |
| Russia | 14,486 | 95,658 | 33,120 | 269,717 | 19,103 | 186,590 |
| British India | 145,140 | 735,967 | 140,965 | 682,897 | 106,580 | 501,746 |
| Cuba | 2,950 | 11,800 | 2 | 26 | | |
| France | 5,974 | 79,093 | 4,853 | 63,933 | 4,043 | 51,648 |
| Netherlands | 1,074 | 11,037 | 55 | 935 | 114 | 1,992 |
| Japan | 1,272 | 17,739 | 952 | 14,277 | | |
| Germany | 2,613 | 57,916 | 4,928 | 83,369 | 3,941 | 76,940 |
| United Kingdom | 1,385 | 40,525 | 2,330 | 35,718 | 600 | 12,810 |
| Canada | 766 | 9,234 | 15 | 704 | 32 | 745 |
| Belgium | 1,505 | 22,617 | 1,378 | 15,202 | 837 | 11,401 |
| All other countries | | | | | 2 | 150 |
| Total | 212,765 | 1,405,329 | 242,348 | 1,711,131 | 176,852 | 1,186,791 |

*Manganese ores imported into the United States, 1909–1911, by customs districts, in long tons.*

| Customs districts. | 1909 | | 1910 | | 1911 | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Philadelphia, Pa | 62,717 | $381,730 | 104,855 | $679,974 | 72,581 | $431,455 |
| Baltimore, Md | 143,122 | 891,758 | 131,526 | 930,902 | 99,008 | 658,421 |
| New York, N. Y | 5,146 | 98,762 | 3,548 | 67,683 | 3,830 | 69,260 |
| Boston, Mass | 52 | 1,041 | 1 | 32 | 5 | 259 |
| New Orleans, La | | | 1,720 | 16,293 | | |
| All others | 1,728 | 32,038 | 698 | 16,247 | 1,428 | 27,396 |
| Total | 212,765 | 1,405,329 | 242,348 | 1,711,131 | 176,852 | 1,186,791 |

The table following shows the total quantity of manganese ore imported into the United States as far as has been recorded. The figures from 1868 to 1888 represent imports from Canada only; those from 1889 to the present time represent total imports.

*Imports of manganese ore into the United States, 1868–1911, in long tons.*

| Year ending— | Quantity. | Year ending— | Quantity. |
|---|---|---|---|
| June 30— | | Dec. 31—Continued. | |
| 1868 | 1,017 | 1890 | 34,154 |
| 1869 | 488 | 1891 | 28,825 |
| 1870 | 1,402 | 1892 | 58,572 |
| 1871 | 1,056 | 1893 | 68,113 |
| 1872 | 1,206 | 1894 | 44,655 |
| 1873 | 838 | 1895 | 86,111 |
| Dec. 31— | | 1896 | 31,489 |
| 1873 | 1,031 | 1897 | 119,961 |
| 1874 | 782 | 1898 | 114,885 |
| 1875 | 203 | 1899 | 188,349 |
| 1876 | 412 | 1900 | 256,252 |
| 1877 | 891 | 1901 | 165,722 |
| 1878 | 626 | 1902 | 235,576 |
| 1879 | 1,886 | 1903 | 146,056 |
| 1880 | 2,179 | 1904 | 108,519 |
| 1881 | 1,704 | 1905 | 257,033 |
| 1882 | 894 | 1906 | 221,260 |
| 1883 | 1,326 | 1907 | 209,021 |
| 1884 | 603 | 1908 | 178,203 |
| 1885 | 1,684 | 1909 | 212,765 |
| 1886 | 1,818 | 1910 | 242,348 |
| 1887 | 1,630 | 1911 | 176,852 |
| 1888 | 1,182 | | |
| 1889[a] | 4,286 | Total | [b] 3,213,865 |

[a] Figures prior to 1889 represent imports from Canada only, total importations from other countries for these years not being obtainable.
[b] This total duplicates the importation from Jan. 1 to June 30, 1873.

## PRODUCTION IN PRINCIPAL PRODUCING COUNTRIES.

The following table gives the latest available statistics with regard to American and foreign production of manganese ore.

*Production of manganese ore in principal producing countries, 1908–1910, in long tons.*

| Country. | 1908 | 1909 | 1910 |
|---|---|---|---|
| North America: | | | |
| United States | 6,144 | 1,544 | 2,258 |
| South America: | | | |
| Brazil[a] | 163,506 | 236,982 | (b) |
| Europe: | | | |
| Austria | 16,394 | 17,761 | (b) |
| Belgium | 7,018 | 6,171 | ..... |
| Bosnia and Herzegovina | 6,791 | 5,602 | (b) |
| Hungary | 10,410 | 11,733 | (b) |
| France | 15,615 | 9,252 | (b) |
| German Empire | 66,626 | 75,962 | (b) |
| Greece | 10,581 | 5,289 | (b) |
| Italy | 2,707 | 4,626 | (b) |
| United Kingdom | 6,308 | 2,768 | 5,467 |
| Russia | 356,597 | 588,456 | (b) |
| Spain | 16,678 | 7,703 | (b) |
| Sweden | 4,594 | 5,189 | (b) |
| Turkey | [c] 14,123 | (b) | (b) |
| Asia: | | | |
| China | ..... | 1,500 | (b) |
| India | 674,315 | 642,675 | (b) |
| Japan | 10,955 | 8,708 | (b) |
| Java | 1,181 | ..... | (b) |
| Philippine Islands | ..... | (d) | ..... |
| Portuguese India | (e) | (b) | (b) |
| Oceania: | | | |
| Queensland | 1,381 | 603 | (b) |

[a] Exports. [b] Statistics not yet available. [c] Year ending March, 1908.
[d] Quantity not stated. Value of production, $6,250. [e] Quantity not stated. Exports valued at $32,674.

## MANGANIFEROUS ORES.

### PRODUCTION.

The total production of manganiferous ores in the United States in 1911 amounted to 522,357 long tons, as compared with 619,735 tons in 1910, a decrease of 97,378 tons. The Lake Superior region produced 477,920 tons, or over 91 per cent of the total, but the percentage of manganese in the Lake ore is low, running generally less than 6 per cent, and the ore was used simply as a source of high-manganese pig iron. The manganiferous ore from Colorado, 41,753 tons, was reported as used for fluxing. The manganiferous iron ore mined near Batesville, Ark., amounting to 2,177 tons, was used in the manufacture of high-manganese pig iron, in blast furnaces at St. Louis, Mo. No manganiferous ore has been reported as produced in Colorado for use in manufacture of ferromanganese and spiegeleisen since 1909.

The following table gives the quantity, value, average price per ton, and the manganese content of the ores used principally for fluxing purposes, 1908 to 1911, inclusive, in Arkansas and Colorado:

*Production of manganiferous ores used principally for fluxing or other purposes in Colorado and Arkansas, 1908–1911, in long tons.*

| Year. | State. | Percentage of manganese. | Quantity. | Value. | Average price per ton. |
|---|---|---|---|---|---|
| 1908 | Arkansas | 14 | 4,066 | $9,149 | $2.25 |
| | Colorado | 6–22 | 35,581 | 83,939 | 2.36 |
| 1909 | Arkansas | 28 | 3,325 | 5,819 | 1.75 |
| | Colorado | | 52,119 | 179,813 | 3.45 |
| 1910[a] | Arkansas | 20–25 | 5,030 | 9,700 | 1.93 |
| | Colorado | 5–26 | 55,770 | 176,448 | 3.16 |
| 1911[a] | Arkansas | 20 | 2,177 | 5,354 | 2.45 |
| | Colorado | 4–40 | 41,753 | 109,340 | 2.62 |
| Total | | | 199,821 | 579,562 | 2.90 |

[a] Marketed production.

The following table gives the total production of all kinds of manganiferous ores in the United States so far as records are available. The disposition of the western ores has been already mentioned. All the eastern ore was presumably used in the manufacture of iron-manganese alloys. The figures for 1910 and 1911 represent marketed production.

*Production of manganiferous ores in the United States, 1885–1911, in long tons.*

| Year. | Arkansas. | Colorado.[a] | Colorado.[b] | Lake Superior region. | Virginia. | Other States. | Total. |
|---|---|---|---|---|---|---|---|
| 1885 | | | | | | (Mont.)[b] 4,263 | 4,263 |
| 1886 | | | [c] 60,000 | 257,000 | | | 317,000 |
| 1887 | | | [c] 60,000 | 210,000 | 1,025 | [d] 726 | 271,751 |
| 1888 | | | [c] 60,000 | 201,636 | | [e] 1,096 | 262,132 |
| 1889 | | | 64,987 | 81,359 | | | 146,346 |
| 1890 | | [e] 6,397 | 51,840 | 61,863 | | | 120,100 |
| 1891 | | [f] 964 | 79,511 | 132,511 | | | 212,986 |
| 1892 | | 2,942 | 62,309 | 147,431 | 3,000 | | 215,682 |

[a] Manganiferous silver ore used in the manufacture of spiegeleisen and ferromanganese.
[b] Manganiferous silver ore used for flux; mainly from Colorado, but in a few cases probably including other Western States.
[c] Contains some Montana ore.
[d] Georgia 195 tons, Maine 50 tons, and Vermont 481 tons.
[e] North Carolina, South Carolina, and Tennessee 96 tons, and Vermont 1,000 tons.
[f] Published as manganese ore in previous volumes of Mineral Resources.

*Production of manganiferous ores in the United States, 1885–1911, in long tons*—Contd.

| Year. | Arkansas. | Colorado. | Colorado. | Lake Superior region. | Virginia. | Other States. | Total. |
|---|---|---|---|---|---|---|---|
| 1893 | 160 | 5,766 | 55,962 | 110,648 | 1,188 | (N. C.) 20 | 173,744 |
| 1894 | ..... | 7,022 | 31,687 | 198,466 | ..... | ..... | 237,175 |
| 1895 | ..... | 13,464 | 54,163 | 112,265 | ..... | ..... | 179,892 |
| 1896 | ..... | 9,072 | 138,079 | 329,640 | ..... | ..... | 476,791 |
| 1897 | ..... | 16,519 | 149,502 | 184,585 | ..... | (Vt.) 1,200 | 351,806 |
| 1898 | ..... | 18,848 | 99,651 | 268,862 | ..... | (Pa.) 100 | 387,461 |
| 1899 | ..... | 29,355 | 79,855 | 732,490 | ..... | ..... | 841,700 |
| 1900 | ..... | 43,303 | 188,509 | 334,274 | ..... | ..... | 566,086 |
| 1901 | ..... | 62,385 | 228,187 | 512,084 | ..... | (N. C.) 20 | 802,676 |
| 1902 | ..... | 13,275 | 194,132 | 884,939 | 3,000 | ..... | 1,095,346 |
| 1903 | ..... | 14,856 | 179,205 | 566,835 | 2,802 | ..... | 763,698 |
| 1904 | 600 | 17,074 | 105,278 | 365,572 | ..... | ..... | 488,524 |
| 1905 | 3,321 | 45,837 | 81,738 | 720,098 | ..... | ..... | 850,994 |
| 1906 | 8,900 | 32,400 | (*a*) | *b* 1,000,000 | ..... | ..... | *b* 1,041,300 |
| 1907 | 4,133 | 67,514 | 32,197 | 314,316 | ..... | (N. M.) 7,000 | 425,160 |
| 1908 | 4,066 | 15,973 | 35,581 | 467,140 | 274 | ..... | 523,034 |
| 1909 | 3,325 | 12,905 | 52,119 | 775,035 | 305 | ..... | 843,689 |
| 1910 | 5,030 | ..... | 55,770 | 558,634 | 301 | ..... | 619,735 |
| 1911 | 2,177 | ..... | 41,753 | 477,920 | 507 | ..... | 522,357 |
| Total | 31,712 | 435,871 | 2,242,015 | 10,005,003 | 12,402 | 14,425 | 12,741,428 |

*a* Not recorded. *b* Estimated.

## MANGANIFEROUS ZINC RESIDUUM.

### PRODUCTION.

The material classed under this head is a residual product from certain zinc oxide works using New Jersey zinc ores. The crude ore consists of a mixture of franklinite, zincite, and willemite, the first being predominant. During roasting the bulk of the zinc is removed as zinc oxide, and the residuum consists of a mass of manganese and iron oxides. This residuum is used for the manufacture of spiegeleisen and ferromanganese. In 1911 the production of manganiferous zinc residuum amounted to 109,296 long tons, valued at $291,344, as compared with 137,173 long tons, valued at $411,519, in 1910, a decrease in quantity of 27,877 long tons and in value of $120,175. The following table shows the quantity, value, and average price per ton of manganiferous zinc residuum produced from 1905 to 1911, inclusive:

*Production of manganiferous zinc residuum in the United States, 1905–1911, in long tons.*

| Year. | Quantity. | Value. | Average price per ton. |
|---|---|---|---|
| 1905 | 90,289 | $90,289 | $1.00 |
| 1906 | 93,461 | 93,461 | 1.00 |
| 1907 | 93,413 | 280,239 | 3.00 |
| 1908 | 110,225 | 330,675 | 3.00 |
| 1909 | 141,264 | 423,792 | 3.00 |
| 1910 | 137,173 | 411,519 | 3.00 |
| 1911 | 109,296 | 291,344 | 2.67 |
| Total | 775,121 | 1,921,319 | 2.48 |

The following table gives the production of manganiferous zinc residuum in the United States so far as has been recorded:

*Production of manganiferous residuum from zinc roasting in the United States, 1889–1911, in long tons.*[1]

| | | | |
|---|---|---|---|
| 1889 | 43,648 | 1902 | 65,246 |
| 1890 | 48,560 | 1903 | 73,264 |
| 1891 | 38,228 | 1904 | 68,189 |
| 1892 | 31,859 | 1905 | 90,289 |
| 1893 | 37,512 | 1906 | 93,461 |
| 1894 | 26,981 | 1907 | 93,413 |
| 1895 | 43,249 | 1908 | 110,225 |
| 1896 | 44,935 | 1909 | 141,264 |
| 1897 | 33,924 | 1910 | 137,173 |
| 1898 | 48,502 | 1911 | 109,296 |
| 1899 | 65,010 | | |
| 1900 | 87,110 | Total | 1,583,649 |
| 1901 | 52,311 | | |

## FERROMANGANESE AND SPIEGELEISEN.

### PRODUCTION.

The total marketed production of ferromanganese and spiegeleisen in the United States in 1911 was 178,615 long tons, as compared with 226,216 long tons produced in 1910. This represents a loss of 47,601 tons, or about 2.1 per cent, from the total for 1910. Spiegeleisen was produced in 1911 in Pennsylvania and Illinois and ferromanganese in Pennsylvania.

*Production of spiegeleisen and ferromanganese in the United States, 1872–1911, in long tons.*

| | | | |
|---|---|---|---|
| 1872 | 4,072 | 1893 | 81,118 |
| 1873 | 3,930 | 1894 | 120,180 |
| 1874 | 4,070 | 1895 | 171,724 |
| 1875 | 6,993 | 1896 | 131,940 |
| 1876 | 5,907 | 1897 | 173,695 |
| 1877 | 7,897 | 1898 | 213,769 |
| 1878 | 9,530 | 1899 | 219,768 |
| 1879 | 12,438 | 1900 | 255,977 |
| 1880 | 17,503 | 1901 | 291,461 |
| 1881 | 18,827 | 1902 | 212,934 |
| 1882 | 19,610 | 1903 | 192,661 |
| 1883 | 21,941 | 1904 | 219,446 |
| 1884 | 30,262 | 1905 | 289,983 |
| 1885 | 30,956 | 1906 | 300,500 |
| 1886 | 42,841 | 1907 | 339,348 |
| 1887 | 42,498 | 1908 | 152,018 |
| 1888 | 48,901 | 1909 | 225,040 |
| 1889 | 76,628 | 1910 | 226,216 |
| 1890 | 133,180 | 1911[2] | 178,615 |
| 1891 | 127,766 | | |
| 1892 | 179,131 | Total | 4,841,274 |

### PRICES OF IRON-MANGANESE ALLOYS.

The prices of iron-manganese alloys vary with the content of these metals. However, as the alloys are generally made with a fairly definite composition, the prices vary only within small limits.

[1] The manufacture of spiegeleisen from manganiferous residuum was begun in 1870, but there is no record of the tonnage of raw material used prior to 1889.

[2] Marketed production. Figures collected by United States Geological Survey.

The following table shows the average range of prices for various iron-manganese alloys during 1910 and 1911:

*Prices per long ton of iron-manganese alloys during 1910 and 1911.*

| Alloy. | Approximate percentage of manganese and silicon. | Price. | |
|---|---|---|---|
| | | 1910 | 1911 |
| Ferromanganese [a] | 75–80 Mn | $39.45–$45.95 | $36.95–$40.45 |
| Spiegeleisen [a] | 15–20 Mn | 23.00– 28.50 | 21.50– 25.90 |
| Silicospiegel [a] | 15–20 Mn, 10–12 Si | 25.00– 29.00 | 24.40– 26.90 |

[a] Compiled from weekly tables in the Industrial World, Pittsburgh.

## IMPORTS.

Important and generally increasing quantities of iron-manganese alloys are imported into the United States annually. Owing to the depression in the iron and steel industry the imports of both ferromanganese and spiegeleisen decreased considerably in 1911 as compared with 1910. The following table gives the quantity and value of ferromanganese and spiegeleisen imported into the United States from 1903 to 1911, inclusive:

*Ferromanganese and spiegeleisen imported and entered for consumption, 1903–1911, in long tons.*

| Year. | Ferromanganese. | | Spiegeleisen. | | Total. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1903 | 41,519 | $1,699,666 | 122,015 | $2,709,317 | 163,534 | $4,408,983 |
| 1904 | 21,813 | 707,037 | 4,623 | 132,461 | 26,436 | 839,498 |
| 1905 | 52,841 | 1,884,651 | 55,457 | 1,336,104 | 108,298 | 3,220,755 |
| 1906 | 84,359 | 4,953,644 | 103,268 | 2,942,940 | 187,627 | 7,896,584 |
| 1907 | 87,400 | 5,354,656 | 48,994 | 1,399,381 | 136,394 | 6,754,037 |
| 1908 | 44,624 | 1,860,664 | 4,579 | 125,054 | 49,203 | 1,985,718 |
| 1909 | 88,934 | 3,396,381 | 16,921 | 356,447 | 105,855 | 3,752,828 |
| 1910 | 114,228 | 4,341,071 | 25,383 | 489,049 | 139,611 | 4,830,120 |
| 1911 | 80,263 | 3,015,062 | 20,970 | 405,444 | 101,233 | 3,420,506 |

## SOURCES OF MANGANESE.

The principal manganese minerals forming ores of manganese are the following:

*Principal manganese minerals.*

| Mineral. | Composition. | Percentage of manganese. |
|---|---|---|
| Polianite | $MnO_2$ | 63.2 |
| Pyrolusite | $MnO_2.n\,H_2O$ | 60–63 |
| Psilomelane | $MnO_2.(MnKBa)O.n\,H_2O$ | 45–60 |
| Wad | Hydrous impure mixture of manganese oxides | Variable. |
| Manganite | $Mn_2O_3.H_2O$ | 62.4 |
| Braunite | $3Mn_2O_3.MnO.SiO_2$ | 69 |
| Franklinite | $(FeZnMn)O.(FeMn)_2O_3$ | Variable. |
| Rhodochrosite | $MnO.CO_2$ | 47.56 |
| Rhodonite (manganese pyroxene) | $MnO.SiO_2$ | 41.9 |
| Tephroite (manganese olivine) | $2MnO.SiO_2$ | 54.3 |
| Spessartite (manganese garnet) | $3MnO.Al_2O_3.3SiO_2$ | 33.3 |

These minerals occurring separately or combined among themselves or with other minerals form four different classes of materials from which manganese is obtained commercially: (1) Manganese ores; (2) manganiferous iron ores; (3) manganiferous silver ores; and (4) manganiferous zinc residuum. Manganese ores consist of various mixtures of manganese oxides, sometimes containing admixtures of manganese carbonate.

*Manganese ores.*—Deposits of manganese ore occur in many parts of the United States, but are most abundant in the Appalachian and Piedmont regions, in the southern Mississippi Valley, and on the Pacific coast. Small deposits occur in the New England, Rocky Mountain, and Great Basin regions. The principal producing districts up to the present have been the James River-Staunton River and the Blue Ridge regions in Virginia; the Cave Spring and Cartersville districts in Georgia; the Batesville district in Arkansas; and the Livermore-Tesla districts in California. Of minor importance are the New River region in Virginia, the northeastern Tennessee region, the McCormick region in South Carolina, and the Little Grande district in Utah. At present mining and shipping is confined in Virginia to the Blue Ridge and James River-Staunton River regions.

*Manganiferous iron ores.*—Manganiferous iron ores consist of mixtures of manganese and iron oxides. Manganiferous iron ores occur in the United States chiefly in the New England, the Appalachian, and the Lake Superior regions, and minor deposits are found in the southern Mississippi Valley and in the Rocky Mountain region. High-grade manganiferous iron ore used for its manganese content occurs in the Appalachian region. Other manganiferous iron ores are produced in the Appalachian and the Lake Superior districts which are so low in manganese that they are classed as iron ores. In the blast furnace they yield a "high-manganese" pig iron, which is used for special purposes.

*Manganiferous silver ores.*—Manganiferous silver ores consist of mixtures of manganese and iron oxides with small quantities of silver sulphide and lead carbonate. As a rule, the iron content exceeds the manganese content, but locally the iron is altogether absent.

Manganiferous silver ores are divided into three classes, according to their uses. (1) The greater portion of the manganiferous silver ores are used for their silver and lead content. Manganese and iron content often insures those ores a higher price because of their fluxing value. (2) A second class of manganiferous silver ore is too low in silver and lead to be used as a source for these metals, but is sufficiently high in manganese and iron to be used for the manufacture of ferromanganese and spiegeleisen, as is the case with the high-grade manganiferous iron ores already mentioned. (3) There is a third class of manganiferous silver ore too low in silver and lead to be used primarily for these metals and too low in iron and manganese to be used for the manufacture of iron-manganese alloys. This ore is sold to the smelters as flux, the iron and manganese becoming waste products, while the silver and lead content is recovered during the smelting.

Manganiferous silver ores occur in the Rocky Mountain and Great Basin regions, the principal producing locality being Leadville, Colo. Some of the Leadville ores are used in the manufacture of spiegeleisen. All the other localities produce these ores for fluxing only.

*Manganiferous zinc residuum.*—Manganiferous zinc residuum is an artificial furnace product consisting of mixtures of manganese and iron oxides in a matrix of slag. Manganiferous zinc residuum is obtained from zinc volatilizing and oxidizing furnaces using New Jersey zinc ores. The residuum consists largely of iron and manganese oxides, the zinc having been removed by volatilization and collected as zinc oxide. The crude ores consist of franklinite, zincite, and willemite, and are obtained only from the Franklin Furnace district, New Jersey. Small quantities of zinc residuum are used annually in the manufacture of spiegeleisen.

## USES OF MANGANESE.

The principal use of manganese ores is in the manufacture of iron-manganese alloys such as spiegeleisen, ferromanganese, silverspiegel, and silicomanganese. The first two of these contain principally iron and manganese; the last two contain considerable silicon in addition. Ferromanganese and spiegeleisen are used in steel manufacture as reducers of iron oxide during the final melting, as recarburizers, and in the manufacture of special steels alone or in combination with chromium, nickel, tungsten, and other steel-hardening metals. Manganese is also used in the formation of alloys with copper, aluminum, zinc, tin, and other metals.

Manganese ores or manganiferous iron ores are used to a slight extent as fluxes in the reduction of silver, lead, and copper ores.

Manganese peroxide is used as an oxidizer in the manufacture of chlorine, bromine, and oxygen, and of potassium ferromanganate; as a drier in paints and varnishes; as a decolorizer of glass; and in the manufacture of the dry and the Leclanche cells. As a coloring material, manganese is used in coloring glass, bricks, and pottery. Several manganese salts are used in drying cloth and as paints.

More complete discussions of the sources, uses, and occurrence of manganese ore may be found in a general report on manganese recently published by the Survey.[1]

## NOTES ON DOMESTIC MANGANESE ORE.

In the Western States manganese ore is found associated with many other metalliferous ores. From Arizona manganese ore has been reported in association with copper ore at Globe and at Bisbee. From Colorado, near Redcliff, Eagle County, a vein of manganese ore with bismuth, graphite, and sulphides carrying gold and silver, has been reported. In New Mexico a promising vein of manganese ore has been discovered in the Las Animas district. It is not certain that any of these occurrences will prove to be of commercial importance. In Tennessee[2] a deposit occurs near the west line of Bradley County, about 8 miles west of Cleveland, on the east flank of White-oak Ridge, near Taliaferro Gap. The manganese area is underlain by Fort Payne chert, and extends northeast-southwest for about 2½ miles. The manganese ore has the appearance of a secondary deposit

[1] Harder, E. C., Manganese deposits of the United States, with sections on foreign deposits, chemistry, and uses: Bull. U. S. Geol. Survey No. 427, 1910.

[2] Nelson, W. A., A new manganese deposit in Tennessee: Resources of Tennessee, Tennessee Geol. Survey, December, 1911, pp. 220–228.

in the Fort Payne chert. It occurs in bands and nodules in the chert and replaces impure chert and limestone which has been leached by circulating water. The deposit occurs in the form of a "blanket" conforming with the contour of the ridge, and is covered generally by 2 or 3 feet to 10 feet of sandy clay soil. Associated with the ore, which is a mixture of manganese oxides, is limonite, or brown iron ore, a hydrated iron oxide. Where the ore is rich in manganese there is little limonite, and as the manganese decreases the limonite increases. All the ore is siliceous, the percentage of silica increasing with depth, as would be expected from the nature of the association of the ore with chert. This ore should be cleaned and concentrated by crushing, picking, and jigging, before being shipped. The principal detriment to exploitation of this deposit under present market conditions, provided a sufficient quantity of good ore shall be proved, is its distance from the railroad, as the product must be hauled by wagons to Cleveland.

A small vein of manganese ore was noted by Mr. J. R. Ryan, who assisted the writer in making an iron-ore survey in east Tennessee in the summer of 1911. This vein was associated with Fort Payne chert in Rhea County, about $1\frac{3}{4}$ miles northeast of Graysville. If this should, on prospecting, prove workable, it is so situated as to insure cheap haulage to the railroad.

Near Newport, Tenn., are large deposits of manganese ore from which some shipments have been made in the past. It is reported that washers are to be installed and the mines equipped for a steady output.

## NOTES ON FOREIGN ORES OF MANGANESE.

### RUSSIA.

The following excerpts from an article by Vice Consul Frederic W. Cauldwell, Batum, Russia, published in the Daily Consular and Trade Reports by the Bureau of Manufactures, Department of Commerce and Labor, May 7, 1912, should be of interest to consumers of manganese ores as well as to domestic producers who desire to become acquainted with conditions abroad.

#### MANGANESE ORE IN THE CAUCASUS.

The manganese deposits of the Caucasus are among the richest in the world. The principal mines are situated at Tchiatouri, in the Government of Kotais, about 190 versts (126 miles) from the Black Sea ports of Batum and Poti. The exploitation of the Tchiatouri mines began in 1878, but remained on a very limited scale until 1885, when the Trans-Caucasian Railway was constructed.

The ore is shipped to England, Germany, the United States, France, and Belgium, and in smaller quantities to other countries. England, Germany, and the United States are the best customers. The total export of the ore from Batum and Poti during the past four years has been as follows:

| Ports. | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Poti | 366,600 | 544,000 | 364,500 | 442,460 |
| Batum | 8,160 | 25,500 | 36,215 | 129,233 |
| Total | 374,760 | 569,500 | 400,715 | 571,693 |

The increase of the shipments from Batum during 1911 is attributed to the heavier cost of loading ore at Poti owing to the levying, in 1910, of a duty of one-half kopeck per pood (0.2575 cent per 36.112 pounds) on ore exported from that port. Manganese shippers at Batum loaded several steamers with full cargoes during the first two months of the current year, and there is every reason to assume that the exports from Batum in 1912 will equal, if not surpass, those of 1911. About 15 or 20 per cent of the manganese exported is washed ore.

*Declared exports—shipments to other countries.*—Manganese ore declared for export to the United States through the consulate at Batum amounted in 1910 to 28,490 tons of a value of $259,898. In 1911 the export amounted to 19,685 tons, with a declared value of $197,737. These figures represent but a part of the ore from the Caucasus that was imported into the United States. Much of the ore sent to European countries is eventually transshipped and finds its way to the United States. Three full shiploads are sent, on an average, each year direct from Batum and Poti to the United States in chartered vessels.

Until the beginning of 1911, no statistics were kept at the customhouses of Batum and Poti that would show to what countries the shipments of manganese ore from these ports went. The statistics now available for 1911 give the following destinations of exports:

| Exported to— | From Poti. | From Batum. | Exported to— | From Poti. | From Batum. |
|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | | *Tons* | *Tons.* |
| Austria | 8,928 | 4,256 | Spain | 30,390 | ..... |
| Belgium | 53,315 | 12,994 | United States (by direct boat) | 5,450 | 10,694 |
| France | 29,925 | 15,885 | | | |
| Germany | 4,345 | 25,536 | | | |
| Great Britain | 105,943 | 31,869 | Total | 442,460 | 129,233 |
| Netherlands | 204,164 | 27,999 | | | |

The ore credited to the Netherlands is in reality destined for Germany. From Rotterdam the ore is sent up the Rhine to the iron districts of Germany.

*Rich ore.*—The ore exported through the ports of Batum and Poti generally contains 48 to 52 per cent of manganese metal (Mn), while concentrates obtained from washing the granular ore and used for chemical purposes (glass making) are shipped containing 81 to 90 per cent of manganese dioxide ($MnO_2$). * * *

*Geologic formation—Extent of deposits.*—The mines at Tchiatouri lie in a region of horizontal sedimentary formations, divided into two principal parts by the Kvirili River. These are again crossed by numerous branches of the river, and the whole region is thus divided into seven plateaus: On the right side of the Kvirili River—Rgani, Sedergani, Mguemevi, Darkveti; on the left side—Perevissi, Choucrouti, Itkhrvisi. The total area covered by these mines is about 126 square versts (about 55 square miles), of which 100 square versts (44 square miles) contain good ore.

The outcroppings of the ore are about 1,000 feet higher than the Kvirili River. The ore lies in a horizontal bed between limestone below and sandstone above. Besides solid benches, the ore also occurs in granules (oolitic form) mixed with sandstone. The richest ore has been found in the plateaus of Mguemevi, Sedergani, and Choucrouti; Rgani Plateau yields rich wash ore.

According to calculations of Russian geologists the Tchiatouri mines contain about 1,070,000,000 tons of ore, estimated to be sufficient to supply Europe and the United States for at least half a century, especially as the Tchiatouri ore is of high quality. As already mentioned, the ore lies in horizontal layers and consequently the mines can be worked easily and at the same time over great areas by means of tunnels (galleries) and by using picks and shovels.

*Mining and transportation methods.*—The mines are owned by a large number of Georgian peasants, who are without capital or knowledge of mining. Until recently, with few exceptions, the mines have been worked in a most primitive way, and as a result only about two-thirds of the ore has been recovered. Within the last six years various foreign firms bought up some of the larger plots and have started mining by more modern methods. The lump ore is separated by hand from the sandstone; only the ore occurring in granules is separated by water concentration in washing plants. In washing, the granular ore can be concentrated up to 60 per cent of metal or 90 per cent of peroxide of manganese ($MnO_2$), but these percentages are above the averages for the district.

The ore is transported to the railroad at Tchiatouri in two-wheeled oxcarts or by pack horses, and over bad roads, for distances varying from 2 to 5 versts (1.324 to 3.31

miles), at a cost of 2 to 3 kopecks per pood (1.03 to 1.545 cents per 36.112 pounds). The position of the mines is favorable for mechanical transportation of ore, especially by wire ropeways, but on account of lack of capital such methods have begun to be employed only lately and by a few firms.

From Tchiatouri the ore is carried on the Tchiatouri Railway, a 25-mile narrow-gage branch of the main line, to Sharopan. At Sharopan it is transferred into the cars of the Trans-Caucasian Railway and shipped to either Batum or Poti.

*Freight rates—Foreign capital—Storage platforms.*—The freight rate from Tchiatouri to these ports is 70.23 rubles ($36.17) per car of 750 poods (about 12.1 long tons) of ore, which is 9.37 kopecks per pood (4.826 cents per 36.112 pounds). This rate includes all expenses of transshipment at Sharopan and three-fourths kopeck to the Manganese Producers' Association. The greater part of this freight rate is for the distance from Tchiatouri to Sharopan, viz, 5½ kopecks (2.8325 cents) for a distance of 38 versts (25 miles). The remainder of the freight rate, amounting to 3.87 kopecks, is paid for the distance of 162 versts (107 miles) from Sharopan to Batum or Poti. The best business in manganese would therefore seem to be done by the Tchiatouri branch of the State railway. The cost of building this short line was 1,500,000 rubles ($772,500).

As most of the mine owners are Georgian peasants with little capital, the trade in the ore has been principally in the hands of commissionaires working with the assistance of banks, which charge 8 to 9 per cent interest. Of late considerable German capital has been invested in the mines and much of the unworked land is now in the hands of foreign capitalists.

A very important part of the manganese business for the exporter is to have at his disposal a number of well-situated platforms at Tchiatouri, connected with a siding of the railroad, where stock for shipment can be stored. The Tchiatouri Railroad can furnish 400 cars per day at the utmost, and these are divided among the proprietors of platforms at a ratio of 1 car for every 20,000 poods of ore kept in stock. Therefore, the greater the quantity of ore in stock the larger is the number of cars allotted the shipper. At times of heavy shipments from Tchiatouri these rules are strictly followed by the railroad, while in slack times owners of small stocks can obtain as many cars as are free. * * *

*Stream pollution by washing plants.*—A feature of the manganese industry during 1911 was the marked increase in the quantity of ore washed at and about the mines, to the great discomfort of the population using the waters of the Kvirili River for domestic purposes. Most of the washing installations have been erected on the banks of the Kvirili or its tributaries, and the refuse from these plants has polluted its waters to such an extent that complaint was made to the viceroy.

The Manganese Producers' Association has devised a plan which seems likely to meet the exigencies of the case. It is proposed to construct a large basin in the valley of the Kvirili River below Tchiatouri, at which slimes from the washing installations will be arrested. The water would there be purified and the overflow from the dam would be utilized for generating the electric current required for lighting the village of Tchiatouri, for electrifying the Sharopan-Tchiatouri branch railway, and for converting manganese waste sediment into ferromanganese in electric furnaces.

It is estimated that the washing installations now in course of construction when completed will have a daily capacity of about 2,613 tons of ore averaging approximately 53 per cent metallic manganese in the dry state; 1,460 tons of refuse, containing 30 per cent mineral to waste in washing the first-named quantity of ore.

[A list of the principal exporters of manganese ore at Batum and Poti may be secured from the Bureau of Manufactures.]

The Chiaturi (Tchiatouri) manganese industry, according to De Hautpick,[1] is in a comparatively depressed condition. The deposits are very rich, but it is said that the destruction of the trade is partly due to the exploiters, who frequently placed very inferior ore, mixed with dirt, on the European market. The revolution in the Caucasus in 1905, when prices were at a high level, forced foreign consumers to the markets of India and Brazil, and it has been difficult to recover the lost market. High freight rates to the port of Poti and increased rates by sea have done much to retard exportations. In 1911 the

[1] Hautpick, E. de, Russian (Chiaturi) manganese industry: Min. Jour. (London), July 23, Nov. 12, 1910, and Mar. 11, 1911.

industry was characterized by irregular exploitation of the mines and disorganization of trade and export. Only the richest ore is extracted and in such an unsystematic way that a large part of the reserves are rendered useless for further recovery. Prices are reported to be so low as not to pay for working the mines.

De Hautpick suggests, in order to escape price dictation, that the ore be manufactured at home into ferromanganese, using coal necessary for the purpose from the Tkvartchely mines near Poti.

## INDIA.

The following excerpts from a recent article by Carter are of interest in connection with the recent large increases in the production of manganese ore in India:[1]

A period of great prosperity in the steel industry (1905–1907) led to a much larger demand for manganese ore just at a period when the Russian output, the most important source of supply, was reduced by the political disturbances in that country. Prices as a result rose quickly, which developed prospecting in India and elsewhere and led to the discovery and working of new deposits of the ore, together with a much larger output from the mines then in existence.

Manganese mining commenced in British India in 1892, and the yearly output from the mines since that date has steadily increased, with the exception of slight fallings off in 1898, 1902, and 1904, to a maximum of 916,770 metric tons in 1907, so that it is possible India produces more manganese ore at present than Russia. The production of the United States, though large, is chiefly made up of manganiferous ores. Production in India up to 1900 was confined to the Vizgapatam district, in the Madras presidency, but in that year a beginning was made in the Central Provinces and since 1902 the mines in the Central Provinces have provided the bulk of the Indian output. * * *

Manganese ores are to be found in many widely separated districts of India, and almost all the deposits which are of economic importance are found in Archean rocks. Some deposits of a superficial character are found in laterite. Manganese ore was at one time made use of in the manufacture of chlorine and bleaching powder from pyrolusite. For this the ore must contain at least 70 per cent of manganese peroxide, and small quantities of pyrolusite are also employed for various lesser chemical and manufacturing purposes. By manganese dioxide is meant the commercial powder.

The manganese-ore deposits in India can be divided into three divisions in accordance with their origin. The first are those derived from a distinct series of igneous Archean rocks rich in manganese by processes of decomposition of a secondary nature and like replacement, acting within the zone of weathering. This division is represented by the deposits formed in the Vizagapatam district. Second, those derived from manganese, the source of which is very probably the same series of igneous manganiferous rocks referred to, already precipitated from solution as hydrated oxide contemporaneously with the decomposition of the inclosing strata which now compose the subdivision of the Archean group known as the "Dharwars." After the consolidation of the series of sediments the rocks were subjected to more or less severe metamorphism, with the result that an important change in the character of the ore bands, as a rule, occurred, the manganese oxide combining with the intermixed or interstratified clay or sand commonly present, with the formation of manganiferous silicates (especially spessartite, a manganese-alumina garnet, and rhodonite). By later chemical alteration, thought to have taken place at considerable depth before the action of denudation brought the series within the zone of weathering, manganese ores (oxides) were largely re-formed, but recent outcrop oxidation has also contributed in most cases to the surface enrichment of the ore bodies. This division comprises all the important Indian deposits, including those of the Central Provinces which do not come under the headings of the first or third divisions. Third, those derived from manganese compounds disseminated in small proportions throughout the Dharwar series, as a rule, and concentrated by superficial replacement and segregation of the manganese in the decomposed outcrops, and in masses of laterite formed on the outcrops of the underlying rocks, usually Dharwars. This division includes the deposits of Sandur, Mysore, Goa, and other localities. In a limited number of instances the manganese

[1] Carter, H. A., Manganese mining in British India: Min. and Sci. Press, Dec. 20, 1911, pp. 834–835.

is most likely of composite origin, being in part derived from original sedimentary deposits and partly enriched by superficial replacement by means of percolating waters carrying manganese in solution.

There is no difference in the character and mode of occurrence of the deposits divided into the three genetic divisions. The first class is of irregular shape and size, strewn in soft decomposed rock, and as a rule outcropping on level ground. The second class forms regular beds interstratified in metamorphic rocks, usually schists and quartzite with a steep dip, and very frequently forming a background for ridges which stand out above the plain, though this is not the case when the inclosed strata are mostly soft schists. The third class, as a rule, forms the crest of small hills or is found irregularly as segregations and concretions in laterite and subsoil.

As to the resources of India in manganese ore, many millions of tons of oxide exist obtainable by the present open-cut methods, but a general lack of development work in depth prevents any exact estimate being made. Though enormous, the amount is not inexhaustible, and within the next decade or two those best fitted to speak on the subject consider it will be necessary to make use of much second-class ore, crushing and concentrating by mechanical means, and also to consider the adoption of underground work in the larger and more persistent types of deposits. The depths to which salable oxidized ore extends in these deposits is, however, as yet unproved, but it could be ascertained by the aid of diamond drilling. It is, in fact, possible that a general exhaustion of the oxidized ores may ultimately force metallurgists to utilize the unoxidized silicate ores carrying 30 to 40 per cent manganese, but this is not a matter which need disturb the present generation.

The deposits in India are worked by open-cut methods with coolie labor, usually under a contract. The ore is pried out with crowbars, or drilled and blasted, a certain amount of dead work being necessary in the country rock which incloses the deposit. In bowlder ore, concretionary ore in clay, and subsoil the material is simply excavated or turned over, and the lumps of ore picked out by hand. The ore quarried is broken where necessary to a convenient size for handling, and separated from admixed rock or low-grade mineral by sorting and cleaning with small hammers. The waste goes to the dump, while the ore is carried away on the heads of women and children and piled into rectangular heaps, which are then measured and the tonnage calculated from the cubical contents (15 to 20 cubic feet per ton, according to the specific gravity and mechanical condition of the ore). In some of the large mines situated on hills the transport to the stacking ground is facilitated by the use of aerial ropeways and gravity inclines, and chutes are at times used. The total mining costs vary greatly, being as low as rupees 1 to R1–8–0 per ton in the mines of the Central Provinces and as high as R6 in some of the Vizagapatam mines, and in some of the small irregular deposits of Goa and Mysore. The royalty payable in British India is 2.5 per cent of the selling value of the dressed ore at the mine, and the rate per ton has varied between 1 anna and 4 annas, according to manganese prices. In native States a fixed royalty of 4 or 6 annas per ton is usually charged.

When an analytical chemist is employed at the mines the stacks of ore are sampled and analyzed separately, in order to control the grade of the ore and to meet the requirements of the contracts on which it is sold. The manganese content must not be let fall to a point which will entitle the buyers to reject the consignment, and for the same reason the injurious impurities (silica and phosphorus) must be kept within the limit allowed. After the measurement and sampling of the stacks the ore, commonly composed chiefly of a mixture of the manganese minerals, psilomelane and braunite, or pyrolusite, is carried to the railway by bullock carts which hold half to three-quarters of a ton, or by light steam tramways in trains of 25 to 30 cars, each holding 1 or 2 tons. Carting costs 2 to 4 annas per ton per mile, while the tramway service costs about 6 pice. The ports from which the ore is exported are, in order of importance, Bombay, Vizagapatam, Marmagoa, and Calcutta. With Vizagapatam deposits the railway freight to the port costs about R1–4–0, while the Sandur and Mysore ores pay about R5–12–0, and the Central Provinces ores (via Bombay) R8 and (via Calcutta) R10. At the ports the ore is stacked for shipment, which is usually in consignments of 1,000 tons and upward. The charges at the port are R1–4–0 to R1–8–0 per ton, and about the same cost is incurred at the port of destination. The freight to English ports and ports on the Continent is usually about R12 per ton and about R13–8–0 in the United States. Central Provinces ore, via Bombay, costs about R27 delivered c. i. f. at English and continental ports, while Vizagapatam ore costs about R28–8–0. The average cost at which the Indian ores can be placed upon the market will bear favorable comparison with the cost of the Russian and Brazilian ores, and they compete with them. On reaching the ports of destination the ore is unloaded into tramway cars, occasionally into lighters, the weight is determined, and the ore delivered at the works.

## WEST INDIES.

The following note by Consul F. T. F. Dumont, Basse Terre, Guadeloupe, French West Indies, was published in the Daily Consular and Trade Reports for May 23, 1912:

*Manganese ore in West Indies.*—In the exhaustive 300-page Bulletin 427 issued by the United States Geological Survey on "Managnese deposits of the United States, with sections on foreign deposits, chemistry, and uses," the following statement appears:

"A bed of manganese ore of superior quality is reported from the island of St. Martin in the West Indies, and another deposit has recently been found in Haiti."

Mining geologists having made inquiry about the St. Martin deposit the following statement has been secured from its owner:

"This deposit is at Cay Bay in the Dutch part of the island, not far from this town of Philipsburg and quite near the sea. Some 10 or 12 years ago two shipments of manganese were made from this place to New York and sold readily, the analysis showing about 44 or 45 per cent manganese. Not long ago the deposit was visited by a Dutch Government engineer, whose opinion of the same was quite favorable. Though there are outcrops of manganese in various parts of the island, Cay Bay is the only place from which ore suitable for shipment has been obtained."

## BRAZIL.[1]

Important deposits of manganese ore occur in the State of Minas Geraes, some of which have been worked since 1894. The largest mine, the Morro, produces about 60,000 tons of ore annually. The Brazilian manganese is reported to be generally uniform in character, carrying an average of 52 to 53 per cent manganese, 3 to 3.5 per cent iron, and 0.03 to 0.04 per cent phosphorus. All the Brazilian ore is exported. In the States of Bahia and Matto Grosso also considerable manganese is mined. The ore deposits of Brazil are estimated as sufficient to supply the world's requirements for several centuries.

## MEXICO

Manganese ore has recently been reported [2] as occurring in Lower California on the peninsula which separates the Gulf of Concepcion from the Gulf of California. The rocks of the peninsula are of igneous origin, and the manganese ore has been deposited in cracks and crevices and as a cementing material in breccias. There are two areas in this vicinity containing manganese ore differing considerably in character. One is about 1½ miles from the east side of Concepcion Gulf, and is known as the Guadalupe. The other, known as the Gabilan deposit, is on the east side of the peninsula about 14 miles from Guadalupe. The Gabilan deposit contains the purer ore, considerable of which is strewn on the rocky beach in the form of pebbles and bowlders. These deposits have not yet been exploited, but on account of their proximity to water transportation are regarded as promising.

---

[1] Grossman, Mining in Brazil: Min. Jour. (London), Mar. 11, 1911, pp. 235–236.

[2] Wallace, H. V., Deposits of manganese in Lower California: Min. and Eng. World, July 15, 1911, pp. 103–104; Min. and Sci. Press, Aug. 12, 1911, pp. 201–202.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE UNITED STATES IN 1911.

## PREFATORY NOTE.

In the following pages will be found the full report on the five metals gold, silver, copper, lead, and zinc. This complete report is divided into seven sections, the first four giving figures of output for the calendar year in marketable form for these metals as obtained from the smelters, refineries, and mints, and general reviews of the respective industries for the entire country; and the last three giving the production as obtained from the mines, so far as possible in terms of recoverable metal in ores sold or treated during the calendar year, and supplying information in detail relative to the mining industry by States, counties, and mining districts. The figures given in the four general reports are the final official statistics of production for the country and the States for 1911. Further characteristics and differences are fully explained in the individual reports.

The seven sections are as follows:

Gold and silver (general report).
Copper (general report).
Lead (general report).
Zinc (general report).
Gold, silver, copper, lead, and zinc in the Western States (mines report).
Silver, copper, lead, and zinc in the Central States (mines report).
Gold, silver, copper, lead, and zinc in the Eastern States (mines report).

In measurement of ore, concentrates, etc., the short ton of 2,000 pounds is used throughout. The price per unit of metal production (gold excepted, which is fixed by law) is based upon the average for the year 1911 of daily market prices for the metals, as follows:

| | | |
|---|---|---|
| Gold | per fine ounce (troy) | $20.671834625323 |
| Silver, New York price | do | .53 |
| Copper, New York price | per pound | .125 |
| Lead, New York price | do | .045 |
| Zinc (spelter), St. Louis price | do | .057 |

It is to be understood, of course, that the full market values are not received for metals in ore and intermediate products, but only for metals in marketable form, and that the prices vary considerably during the year.

Each of the seven sections is published in a separate pamphlet and may be obtained on request to the Director, United States Geological Survey, Washington, D. C.

# GOLD AND SILVER.

By H. D. McCaskey.[1]

## ACKNOWLEDGMENTS.

To the thousands of men engaged in the mining and metallurgical industries, to merchants, bankers, and transportation officials of the United States and Alaska, to the Bureau of the Mint, the Post Office Department, the Bureau of Foreign and Domestic Commerce of the Department of Commerce and Labor, and to other officials, public and private, who have cooperated with the United States Geological Survey in furnishing information on the production of gold and silver, acknowledgment is most gratefully made. This cooperation is each year more freely given, and the results are correspondingly of increased value, not only to those directly concerned, but also to the public at large.

## PRODUCTION OF GOLD AND SILVER IN 1911.

### GENERAL STATEMENT.

The production of gold and silver in the United States from domestic ores in 1911 is shown in the following table in distribution by States:

*Approximate distribution by producing States and Territories of the production of gold and silver in the United States for the calendar year 1911, in fine ounces.*[a]

| State or Territory. | Gold. | | Silver. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Commercial value. |
| Alabama | 890 | $18,400 | 200 | $100 |
| Alaska | 806,179 | 16,665,200 | 468,300 | 252,900 |
| Arizona | 170,348 | 3,521,400 | 3,228,900 | 1,743,600 |
| California | 964,041 | 19,928,500 | 1,270,900 | 686,300 |
| Colorado | 925,839 | 19,138,800 | 7,331,200 | 3,958,800 |
| Georgia | 1,548 | 32,000 | 600 | 300 |
| Idaho | 65,688 | 1,357,900 | 8,184,900 | 4,419,800 |
| Illinois | | | 4,000 | 2,200 |
| Maryland and Pennsylvania | 5 | 100 | 100 | 100 |
| Michigan | | | 507,700 | 274,100 |
| Missouri | | | 49,100 | 26,500 |
| Montana | 176,554 | 3,649,700 | 12,163,900 | 6,568,500 |
| Nevada | 875,438 | 18,096,900 | 13,185,900 | 7,120,400 |
| New Mexico | 36,847 | 761,700 | 1,341,400 | 724,300 |
| North Carolina | 3,478 | 71,900 | 1,000 | 500 |
| Oregon | 30,679 | 634,200 | 44,800 | 24,200 |
| Philippine Islands | 9,448 | 195,300 | 3,100 | 1,700 |
| Porto Rico | 97 | 2,000 | 100 | 100 |
| South Carolina | 972 | 20,100 | | |
| South Dakota | 359,402 | 7,429,500 | 200,300 | 108,200 |
| Tennessee | 576 | 11,900 | 107,000 | 57,800 |
| Texas | 189 | 3,900 | 444,200 | 239,900 |
| Utah | 217,020 | 4,486,200 | 11,630,600 | 6,280,500 |
| Virginia | 150 | 3,100 | 200 | 100 |
| Washington | 40,635 | 840,000 | 230,300 | 124,400 |
| Wyoming | 1,030 | 21,300 | 700 | 400 |
| Total | 4,687,053 | 96,890,000 | 60,399,400 | 32,615,700 |

[a] Gold value, $20.671834625323 per fine ounce. Average commercial price of silver in 1911, 53 cents per fine ounce.

[1] Valuable aid has been rendered by J. P. Dunlop in the preparation of the tables of this report and in the verification of all the figures.

The figures in this table are also those of the Director of the Mint. They result from cooperation of the Bureau of the Mint and the United States Geological Survey and are agreed upon after conference and adjustment between the two bureaus. They are, therefore, final for both.

The totals of this table are based on bullion deposits in the United States mints and assay offices and on returns to the Bureau of the Mint from the smelting and refining companies. The distribution is adjusted by information collected by the United States Geological Survey direct from the producing mines and tabulated for the mine reports later discussed. The data giving the total production, and in part the distribution, are obtained from records of (1) the unrefined domestic gold and silver deposited in United States mints and assay offices, (2) the domestic gold and silver in fine bars reported by private refineries, and (3) the unrefined domestic gold and silver contained in ores, matte, etc., exported for reduction. The last item is of small relative importance.

Gains and losses in the production of gold and silver in the several States and Territories, as compared with the output of 1909, are shown in the following table:

*Increase (+) or decrease (−) in production of precious metals in the United States in 1911, by States and Territories, in fine ounces.*

| State or Territory. | Gold. | | Silver. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Commercial value. |
| Alabama | − 702 | − $14,500 | − 100 | − $100 |
| Alaska | +19,031 | + 393,400 | + 314,400 | + 169,800 |
| Arizona | + 5,234 | + 108,200 | + 573,200 | + 309,500 |
| California | −24,812 | − 512,900 | − 520,700 | − 281,200 |
| Colorado | −67,130 | −1,387,700 | −1,191,800 | − 643,600 |
| Georgia | + 387 | + 8,000 | + 300 | + 100 |
| Idaho | +15,576 | + 322,000 | +1,157,900 | + 625,200 |
| Illinois | ..... | ..... | + 2,000 | + 1,100 |
| Kentucky | ..... | ..... | − 100 | − 100 |
| Michigan | ..... | ..... | + 245,500 | + 132,500 |
| Missouri | ..... | ..... | + 16,900 | + 9,100 |
| Montana | − 3,421 | − 70,700 | − 119,000 | − 64,200 |
| Nevada | −37,577 | − 776,800 | + 819,900 | + 442,800 |
| Maryland, New Hampshire, and Pennsylvania | − 280 | − 5,800 | − 600 | − 300 |
| New Mexico | +13,762 | + 284,500 | + 562,400 | + 303,700 |
| North Carolina | + 358 | + 7,400 | − 7,300 | − 4,000 |
| Oregon | − 2,284 | − 47,200 | + 1,000 | + 600 |
| Philippine Islands | + 1,979 | + 40,900 | + 1,300 | + 700 |
| Porto Rico | + 49 | + 1,000 | + 100 | + 100 |
| South Carolina | − 857 | − 17,760 | ..... | ..... |
| South Dakota | +99,135 | +2,049,300 | + 79,700 | + 43,100 |
| Tennessee | + 441 | + 9,100 | + 37,200 | + 20,100 |
| Texas | + 170 | + 3,500 | + 79,800 | + 43,100 |
| Utah | + 8,393 | + 173,500 | +1,184,700 | + 639,700 |
| Virginia | + 106 | + 2,200 | ..... | ..... |
| Washington | + 1,645 | + 34,000 | + 25,400 | + 13,800 |
| Wyoming | + 832 | + 17,200 | − 600 | − 300 |
| Total net increase (+) | +30,035 | + 620,900 | +3,261,500 | +1,761,200 |

In addition to the production of gold and silver from domestic sources in 1911, the smelters and refineries produced as refined bullion from foreign ore, matte, and unrefined bullion, 875,156 fine ounces of gold and 69,692,387 fine ounces of silver. Of the foreign gold, 332,322 fine ounces is credited to Mexico, 200,967 ounces to Canada, 153,222 ounces to the Yukon, 52,080 ounces to Central

America, 38,665 ounces to South America, and 97,900 ounces to all other foreign sources. Of the foreign silver 40,277,675 fine ounces are credited to Mexico, 18,994,490 ounces to Canada, 54,914 ounces to the Yukon, 1,951,331 ounces to Central America, 6,121,280 ounces to South America, and 2,292,697 ounces to all other foreign sources.

## PRICES OF SILVER.

The average monthly price of silver in New York in 1911 was as follows:

*Price of silver per fine ounce in New York in 1911, by months.*

| | | | |
|---|---|---|---|
| January | $0.53795 | July | $0.52630 |
| February | .52222 | August | .52171 |
| March | .52745 | September | .52440 |
| April | .53325 | October | .53340 |
| May | .53308 | November | .55719 |
| June | .53043 | December | .54905 |

The average annual New York commercial value of silver per fine onuce for the last 11 years has been:

*Annual price of silver per fine ounce in New York, 1901–1911.*

| | | | |
|---|---|---|---|
| 1901 | $0.60 | 1907 | $0.66 |
| 1902 | .53 | 1908 | .53 |
| 1903 | .54 | 1909 | .52 |
| 1904 | .58 | 1910 | .54 |
| 1905 | .61 | 1911 | .53 |
| 1906 | .68 | | |

## WORLD'S PRODUCTION OF GOLD.

The production of gold in the world since 1860 is shown in the following table from the report of the Director of the Mint for the fiscal year ended June 30, 1911. The output for the calendar year 1911 is estimated from best available sources.

*Production of gold in the world since 1860.*

[The annual production from 1860 to 1872 is obtained from 5-year periods compiled by Dr. Adolph Soetbeer. From 1872 to 1910, inclusive, the estimates are those of the Bureau of the Mint. Figures for 1911 are preliminary from best available sources.]

| Calendar year. | Value. | Calendar year. | Value. | Calendar year. | Value. | Calendar year. | Value. |
|---|---|---|---|---|---|---|---|
| 1860 | $134,083,000 | 1874 | $90,750,000 | 1888 | $110,196,900 | 1902 | $296,737,600 |
| 1861 | 122,989,000 | 1875 | 97,500,000 | 1889 | 123,489,200 | 1903 | 327,702,700 |
| 1862 | 122,989,000 | 1876 | 103,700,000 | 1890 | 118,848,700 | 1904 | 347,377,200 |
| 1863 | 122,989,000 | 1877 | 113,947,200 | 1891 | 130,650,000 | 1905 | 380,288,700 |
| 1864 | 122,989,000 | 1878 | 119,092,800 | 1892 | 146,651,500 | 1906 | 402,503,000 |
| 1865 | 122,989,000 | 1879 | 108,778,800 | 1893 | 157,494,800 | 1907 | 412,966,600 |
| 1866 | 129,614,000 | 1880 | 106,436,800 | 1894 | 181,175,600 | 1908 | 442,476,900 |
| 1867 | 129,614,000 | 1881 | 103,023,100 | 1895 | 198,763,600 | 1909 | 454,145,700 |
| 1868 | 129,614,000 | 1882 | 101,996,600 | 1896 | 202,251,600 | 1910 | 454,703,900 |
| 1869 | 129,614,000 | 1883 | 95,392,000 | 1897 | 236,073,700 | 1911 | 467,449,600 |
| 1870 | 129,614,000 | 1884 | 101,729,600 | 1898 | 286,879,700 | | |
| 1871 | 115,577,000 | 1885 | 108,435,600 | 1899 | 306,724,100 | Total | 9,888,293,800 |
| 1872 | 115,577,000 | 1886 | 106,163,900 | 1900 | 254,576,300 | | |
| 1873 | 96,200,000 | 1887 | 105,774,900 | 1901 | 260,992,900 | | |

An examination of the figures of the table from 1890 to 1911, inclusive, shows a total increase for the period of $349,600,900, a sum exceeded, however, by the single output of each year since 1905. A study of rates of increase for each year since 1890 shows wide variations, as from 9.93 per cent in 1891 over the output of 1890, to 21.52 per cent in 1898 over the output of 1897. In 1900 there was a decrease (the only decrease in the period mentioned) due to the Boer War, which affected the output of the Transvaal; then came an increase of 2.52 per cent in 1901, and then the maximum increase since the Boer War of 13.69 per cent in 1902, followed by an increase of 12.05 per cent in 1903, and by generally decreasing rates of increase from 1904 to date. So far as the grand total is concerned and in view of present knowledge of the world's gold fields, of the supplies of workable ores, and of the prospects for economical methods for working ores not profitable now, the outlook appears to be for a steadily decreasing rate of annual increase of the output of gold. It seems probable that the world's demand for new gold, to supply increasing needs for consumption in the arts and industries, for the constant spreading of the gold basis for national currencies, and for increasing hoarding by natives of such countries as India and Egypt (where this hoarding is becoming partly of gold as well as of silver), will grow at a faster rate than the increase of supply.

To the great increase, in recent years, of the world's supply of gold, has been frequently ascribed the increasing cost of living. The output of gold is, however, but one of many factors in a very complicated problem in which there are many variables and relatively few constants. There are many causes, checks, and balances in operation, some of which may neutralize and some of which may emphasize the value of increasing gold supply as a factor. Great increase of population over increase of production of food supplies and other necessaries of life, control of prices and supplies by powerful agencies as opposed to a real competitive basis for sales, and high cost of labor are presumably among many factors that seem competent to increase living costs independent of the gold supplies. The psychological factor alone of growth of reckless expenditure and speculation, especially during periods of prosperity and independent of gold supplies, appears capable of lowering purchasing power and thereby increasing living costs.

In the following table is shown the output of gold, by countries, for the 10 years ending 1911:

*World's production of gold, 1902–1911, by countries.*

| Country. | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 |
|---|---|---|---|---|---|---|
| North America: | | | | | | |
| United States | $80,000,000 | $73,591,700 | $80,464,700 | $88,180,700 | $94,373,800 | $90,435,700 |
| Canada | 21,336,700 | 18,834,500 | 16,462,500 | 14,610,400 | 12,023,900 | 8,382,800 |
| Mexico | 10,153,100 | 10,677,500 | 12,605,300 | 16,107,100 | 18,534,700 | 18,681,100 |
| Africa | 39,023,700 | 67,998,100 | 85,913,900 | 113,254,700 | 135,358,000 | 151,984,100 |
| Australasia | 81,578,800 | 89,210,100 | 87,767,300 | 85,926,500 | 82,391,400 | 75,677,700 |
| Europe: | | | | | | |
| Russia and Finland | 22,534,700 | 24,634,200 | 24,803,200 | 22,292,200 | 19,496,500 | 26,684,300 |
| Austria-Hungary | 2,171,300 | 2,245,100 | 2,117,300 | 2,457,400 | 2,615,400 | 2,484,900 |
| Germany | 62,500 | 70,500 | 64,700 | 66,700 | 80,400 | 66,600 |
| Norway | 2,000 | 2,700 | ..... | ..... | ..... | ..... |
| Sweden | 62,500 | 33,900 | 40,200 | 36,700 | 13,300 | 18,700 |
| Italy | 5,300 | 26,700 | 44,000 | 44,000 | 41,200 | 39,600 |
| Spain and Portugal | 11,500 | 6,700 | ..... | ..... | ..... | ..... |
| Turkey | 30,600 | 20,700 | 29,000 | 6,000 | 6,000 | 4,500 |

*World's production of gold, 1902–1911, by countries*—Continued.

| Country. | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 |
|---|---|---|---|---|---|---|
| Europe—Continued. | | | | | | |
| France | | | | | $502,400 | $835,400 |
| Great Britain | $77,300 | $94,000 | $359,800 | $112,700 | 29,200 | 29,200 |
| Servia | | | | | 59,800 | 59,800 |
| South America: | | | | | | |
| Argentina | 30,000 | 30,000 | 9,200 | 5,500 | 5,500 | 103,000 |
| Bolivia | 1,000 | 2,900 | 21,900 | 18,800 | 754,600 | 1,267,400 |
| Chile | 666,900 | 636,900 | 636,900 | 948,500 | | |
| Colombia | 2,522,600 | 2,724,400 | 1,974,400 | 2,584,000 | 2,190,800 | 3,255,600 |
| Ecuador | 200,000 | 274,400 | 132,900 | 188,500 | 294,200 | 267,100 |
| Brazil | 2,099,900 | 2,280,400 | 2,043,500 | 2,044,600 | 2,403,000 | 2,020,700 |
| Venezuela | 433,800 | 300,000 | 300,000 | 171,400 | 25,300 | 22,400 |
| Guiana: | | | | | | |
| British | 1,808,600 | 1,611,300 | 1,608,800 | 1,690,700 | 1,607,700 | 1,304,400 |
| Dutch | 322,000 | 375,900 | 441,600 | 632,500 | 689,200 | 640,000 |
| French | 2,420,200 | 2,101,500 | 1,806,400 | 1,859,700 | 1,858,900 | 2,360,800 |
| Peru | 2,326,100 | 592,600 | 1,329,200 | 516,100 | 829,000 | 514,500 |
| Uruguay | 57,800 | 51,500 | 25,000 | 50,000 | 31,700 | 51,900 |
| Central America | 2,001,900 | 1,875,300 | 1,252,500 | 1,513,400 | 1,910,700 | 2,107,800 |
| Asia: | | | | | | |
| Japan | 1,975,800 | 2,891,200 | 2,948,500 | 3,072,400 | 2,748,900 | 2,773,000 |
| China | 8,731,800 | 7,324,700 | 4,500,000 | 4,500,000 | 4,500,000 | 4,500,000 |
| Indo-China | | | | | | 31,800 |
| Chosen (Korea) | 3,000,000 | 3,000,000 | 3,000,000 | 2,593,000 | 2,283,000 | 2,170,800 |
| Siam | | | 51,800 | 48,600 | 53,200 | 166,200 |
| India, British | 9,588,100 | 11,428,900 | 11,722,900 | 11,950,200 | 12,087,700 | 10,383,600 |
| East Indies, British | 1,027,100 | 1,344,800 | 1,485,300 | 1,391,200 | 1,448,700 | 1,561,300 |
| East Indies, Dutch | 474,000 | 1,409,600 | 1,414,500 | 1,414,500 | 1,254,900 | 2,079,900 |
| Total | 296,737,600 | 327,702,700 | 347,377,200 | 380,288,700 | 402,503,000 | 412,966,600 |

| Country. | 1908 | 1909 | 1910 | 1911 | Total. |
|---|---|---|---|---|---|
| North America: | | | | | |
| United States | $94,560,000 | $99,673,400 | $96,269,100 | $96,233,500 | $893,782,600 |
| Canada | 9,482,100 | 9,382,200 | 10,205,800 | 9,762,100 | 130,483,000 |
| Mexico | 22,371,200 | 23,842,900 | 24,910,600 | 29,196,000 | 187,079,500 |
| Africa | 166,520,500 | 170,988,600 | 175,189,900 | 192,972,100 | 1,299,203,600 |
| Australasia | 73,327,300 | 71,007,900 | 65,470,600 | 59,187,900 | 771,545,500 |
| Europe: | | | | | |
| Russia and Finland | 28,052,200 | 32,381,300 | 35,579,600 | 24,865,000 | 261,323,200 |
| Austria-Hungary | 2,469,300 | 1,942,000 | 2,172,600 | 2,175,000 | 22,850,300 |
| Germany | 64,800 | 69,200 | 62,900 | 3,300,800 | 3,909,100 |
| Norway | | | 1,400 | | 6,100 |
| Sweden | 14,500 | 10,100 | 2,000 | 16,300 | 248,200 |
| Italy | 46,500 | 24,200 | 29,600 | 10,000 | 311,100 |
| Spain and Portugal | | 2,900 | 2,800 | 32,800 | 56,700 |
| Turkey | 2,200 | 2,200 | 2,200 | 29,900 | 133,300 |
| France | 1,147,400 | 1,400,600 | 1,400,600 | 1,588,300 | 6,874,700 |
| Great Britain | 16,000 | 21,500 | 21,500 | 5,600 | 766,800 |
| Servia | 59,800 | 150,300 | | | 329,700 |
| South America: | | | | | |
| Argentina | 161,300 | 189,900 | 173,100 | 182,800 | 890,300 |
| Bolivia | 346,300 | 492,400 | 463,600 | 935,000 | 7,193,100 |
| Chile | | | | | |
| Colombia | 3,427,300 | 3,179,900 | 3,370,000 | 3,425,000 | 28,654,000 |
| Ecuador | 350,300 | 274,400 | 249,200 | 327,000 | 2,558,000 |
| Brazil | 2,196,600 | 2,252,900 | 1,954,700 | 2,851,000 | 22,147,300 |
| Venezuela | 24,500 | 280,600 | 340,500 | 335,700 | 2,234,200 |
| Guiana: | | | | | |
| British | 1,408,100 | 1,192,700 | 1,192,700 | 1,084,200 | 14,509,200 |
| Dutch | 663,000 | 621,000 | 792,600 | 754,500 | 5,932,300 |
| French | 2,135,500 | 2,143,800 | 2,005,800 | 2,950,000 | 21,642,600 |
| Peru | 514,500 | 514,500 | 514,500 | 645,000 | 8,296,000 |
| Uruguay | 91,600 | 91,600 | 91,600 | 68,300 | 611,000 |
| Central America | 3,018,800 | 2,630,100 | 4,657,400 | 3,420,000 | 24,387,900 |
| Asia: | | | | | |
| Japan | 3,321,600 | 3,701,800 | 3,845,400 | 2,990,500 | 30,269,100 |
| China | 8,647,300 | 9,352,100 | 3,658,100 | 10,000,000 | 65,714,000 |
| Indo-China | 65,600 | 65,600 | 65,600 | | 228,600 |
| Chosen (Korea) | 3,047,500 | 1,993,600 | 4,399,100 | 2,264,800 | 27,751,800 |
| Siam | 327,600 | 327,600 | 56,500 | 475,000 | 1,506,500 |
| India, British | 10,598,500 | 10,358,600 | 10,718,400 | 10,463,200 | 109,300,100 |
| East Indies, British | 1,400,900 | 1,436,900 | 1,446,800 | 1,484,300 | 14,027,300 |
| East Indies, Dutch | 2,596,300 | 2,146,400 | 3,387,100 | 2,385,000 | 18,562,200 |
| Other countries | | | | 1,033,000 | 1,033,000 |
| Total | 442,476,900 | 454,145,700 | 454,703,900 | 467,449,600 | 3,986,351,900 |

In the world's output of gold it is seen that since 1905, inclusive, Africa leads by a large margin and with constantly increasing output. The production for 1911 of $192,972,000 may be subdivided into $170,287,000 from the Rand in the Transvaal, $15,606,000 from Rhodesia, $5,204,000 from the West Coast, and $1,875,000 from Madagascar. The output from the Rand has been regularly increasing; that from Rhodesia and Madagascar appears stationary; and that of the West Coast has shown some decrease in the last three years. The great mines of the Rand may be expected to supply an increasing output for a few years, and a vast output for many years more, but the rate of increase will probably steadily decline as a result of the "maximum-tonnage-milled" policy now adopted, which means the increasing use of lower grade ore.

The table also shows a general increase in gold production of the United States (which ranks second in world's output) during the decade, but a fairly stationary output in the neighborhood of $100,000,000 for the last four years. The distribution and details are given elsewhere in this report. From present knowledge of the great gold producers of the United States and of domestic sources of supply it seems clear that the majority of the gold mining camps and fields are producing at probably their maximum annual capacity; and in the absence of important new discoveries the likelihood appears that there is no material increase in output ahead.

Third in rank in world's production of gold is Australasia, including New Zealand and the six States of Australia. The production is given at $59,187,900 for 1911. As shown by the table, the total gold output is on the wane, and from present knowledge no increase can be looked for. Decline in production is noted from every State and from New Zealand for nine years. The greatest part of the production is from Western Australia, where the output was $28,338,000 in 1911. The grade of ore has been generally on the decrease with depth. Next in rank is Victoria, which produced about $10,400,000 in gold in 1911. Production has declined here also, notably from the older fields of Bendigo and Ballarat. Queensland produced about $7,890,000 in 1911, New South Wales about $3,740,000, and Tasmania, South Australia, and the Northern Territory the remainder from Australia. New Zealand's output has not greatly varied in the decade, but has steadily declined. The production is estimated at $8,500,000 for 1911. There is no present prospect for increased output of gold from Australasia.

Mexico took fourth rank in gold production in 1911, with an output of $29,196,000—a marked increase despite internal political dissension of the most serious kind. With increasing introduction of modern mining and metallurgical methods into Mexico and renewed development of the great metal resources of that country the gold output may be expected to increase.

The Russian Empire, including Siberia, ranks fifth in output and produced about $24,865,000 in gold in 1911—a marked decrease from the production of 1910, due mainly to shortage of water in placer workings in Siberia. The Russian production has been generally increasing, and a vast placer gold field undoubtedly awaits development in north Siberia, although this development may be long delayed.

Sixth in world's output of gold is India, where the production was approximately $10,500,000 in 1911. The output has ranged from 10 to 12 millions in India for the last decade and has been practically stationary. The great mines have been well developed for many years, and from present knowledge there is nothing to indicate a material change in India's total gold output for the next few years.

Canada ranks seventh in production, and her total output has generally decreased during the decade, owing to rapid exhaustion of the rich placers of the Yukon. The production was $9,762,000 in 1911, against $21,337,000 in 1902. Deep mining in Canada and new dredge and hydraulic mining on an extensive scale in the Yukon may show somewhat increased total gold production for the next few years.

Central America is credited with $3,420,000 in 1911, Colombia with $3,425,000, and Brazil with $2,850,000. The total gold output from Central America and South America may be expected to show some increase during the next decade.

China is credited with about $10,000,000 in gold output for 1911, Japan with $2,990,500, and Chosen (Korea) with $2,265,000. Little change is expected from these figures in the near future.

## PRODUCTION OF GOLD AND SILVER SINCE 1792.

According to tables published by the Director of the Mint, the total production of gold and silver in the United States from 1792 to 1911, inclusive, is as follows:

*Production of gold and silver in the United States, 1792–1911, by periods, in fine ounces.*

[The estimate for 1792–1872 is by R. W. Raymond, commissioner, and since by the Director of the Mint.]

| Year. | Gold. | | Silver. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Commercial value. |
| 1792–1847 | 1,187,170 | $24,537,000 | 309,500 | $404,500 |
| 1848–1872 | 58,279,778 | 1,204,750,000 | 118,568,200 | 157,749,900 |
| 1873–1911 | 102,999,003 | 2,129,176,500 | 1,836,520,100 | 1,471,817,600 |
| Total | 162,465,951 | 3,358,463,500 | 1,955,407,800 | 1,629,972,000 |

The following table shows the quantity and value of these metals produced in the United States since 1880.

*Production of gold and silver in the United States from 1880 to 1911, inclusive, in fine ounces.*

| Years. | Gold. | | Silver. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Commercial value. |
| 1880 | 1,741,500 | $36,000,000 | 30,318,700 | $34,717,000 |
| 1881 | 1,678,612 | 34,700,000 | 33,257,800 | 37,657,500 |
| 1882 | 1,572,187 | 32,500,000 | 36,196,900 | 41,105,900 |
| 1883 | 1,451,250 | 30,000,000 | 35,732,800 | 39,618,400 |
| 1884 | 1,489,950 | 30,800,000 | 37,743,800 | 41,921,300 |
| 1885 | 1,538,373 | 31,801,000 | 39,909,400 | 42,503,500 |
| 1886 | 1,686,788 | 34,869,000 | 39,694,000 | 39,482,400 |
| 1887 | 1,603,049 | 33,136,000 | 41,721,600 | 40,887,200 |
| 1888 | 1,604,478 | 35,167,500 | 45,792,700 | 43,045,100 |
| 1889 | 1,594,775 | 32,967,000 | 50,094,500 | 46,838,400 |
| 1890 | 1,588,877 | 32,845,000 | 54,516,300 | 57,242,100 |
| 1891 | 1,604,840 | 33,175,000 | 58,330,000 | 57,630,000 |
| 1892 | 1,597,098 | 33,015,000 | 63,500,000 | 55,062,500 |
| 1893 | 1,739,323 | 35,955,000 | 60,000,000 | 46,800,000 |
| 1894 | 1,910,813 | 39,500,000 | 49,500,000 | 31,422,100 |
| 1895 | 2,254,760 | 46,610,000 | 55,727,000 | 36,445,500 |
| 1896 | 2,568,132 | 53,088,000 | 58,834,800 | 39,654,600 |
| 1897 | 2,774,935 | 57,363,000 | 53,860,000 | 32,316,000 |
| 1898 | 3,118,398 | 64,463,000 | 54,438,000 | 32,118,400 |
| 1899 | 3,437,210 | 71,053,400 | 54,764,500 | 32,858,700 |
| 1900 | 3,829,897 | 79,171,000 | 57,647,000 | 35,741,100 |
| 1901 | 3,805,500 | 78,666,700 | 55,214,000 | 33,128,400 |
| 1902 | 3,870,000 | 80,000,000 | 55,500,000 | 29,415,000 |
| 1903 | 3,560,000 | 73,591,700 | 54,300,000 | 29,322,000 |
| 1904 | 3,892,480 | 80,464,700 | 57,682,800 | 33,456,000 |
| 1905 | 4,265,742 | 88,180,700 | 56,101,600 | 34,222,000 |
| 1906 | 4,565,333 | 94,373,800 | 56,517,900 | 38,256,400 |
| 1907 | 4,374,827 | 90,435,700 | 56,514,700 | 37,299,700 |
| 1908 | 4,574,340 | 94,560,000 | 52,440,800 | 28,050,600 |
| 1909 | 4,821,701 | 99,673,400 | 54,721,500 | 28,455,200 |
| 1910 | 4,657,018 | 96,269,100 | 57,137,900 | 30,854,500 |
| 1911 | 4,687,053 | 96,890,000 | 60,399,400 | 32,615,700 |
| Total | 89,459,239 | 1,849,284,700 | 1,600,326,700 | 1,220,743,200 |

## IMPORTS AND EXPORTS.

The following table gives a summary of imports and exports of gold and silver during 1911:

*Imports and exports of gold and silver during the calendar year 1911.*

[Figures furnished by the Bureau of Foreign and Domestic Commerce.]

| Metal. | Imports. | Exports. | Excess of— | |
|---|---|---|---|---|
| | | | Imports. | Exports. |
| GOLD. | | | | |
| Contained in domestic ore and base bullion | | $499,265 | | $499,265 |
| Contained in foreign ore and base bullion | $10,821,418 | | $10,821,418 | |
| Domestic bullion, refined | | 6,062,130 | | 6,062,130 |
| Foreign bullion, refined | 30,423,935 | | 30,423,935 | |
| United States coin | 6,255,447 | 28,426,710 | | 22,171,263 |
| Foreign coin | 9,944,384 | 2,194,969 | 7,749,415 | |
| Total | 57,445,184 | 37,183,074 | 48,994,768 | 28,732,658 |
| Excess of imports | | | 20,262,110 | |
| SILVER. | | | | |
| Contained in domestic ore and base bullion | | 129,909 | | 129,909 |
| Contained in foreign ore and base bullion | 27,395,417 | 64,727 | 27,330,690 | |
| Domestic bullion, refined | | 59,644,416 | | 59,644,416 |
| Foreign bullion, refined | 12,995,538 | 4,889,010 | 8,106,528 | |
| United States coin | 2,211,090 | 111,705 | 2,099,385 | |
| Foreign coin | 1,144,526 | 824,879 | 319,647 | |
| Total | 43,746,571 | 65,664,646 | 37,856,250 | 59,774,325 |
| Excess of exports | | | | 21,918,075 |

In 1911, according to the Bureau of Foreign and Domestic Commerce of the Department of Commerce and Labor, Mexico sent to this country gold valued at $5,342,566 in ore and base bullion and at $16,784,951 in refined bullion, a total value in gold of $22,127,517; and silver valued at $15,570,892 in ore and base bullion and at $9,164,162 in refined bullion, a total value in silver of $24,735,054, and a total value in both metals of $46,862,571, exclusive of coin.

During the same year Nova Scotia, New Brunswick, and Prince Edward Island sent to this country gold valued at $26,200 in ore and base bullion and at $7,217 in refined bullion, and silver in ore and base bullion valued at $370; Quebec, Ontario, Manitoba, etc., sent gold valued at $131,366 in ore and base bullion and at $6,748,104 in refined bullion, and silver valued at $9,642,280 in ore and base bullion and at $701,375 in refined metal; and British Columbia sent gold valued at $3,786,320 in ore and base bullion and at $1,035,227 in refined bullion, and silver valued at $386,037 in ore and base bullion and at $126,047 in refined bullion. The total imports from Canada were gold valued at $11,734,434, and silver valued at $10,856,109, a total of $22,590,543, not including a large amount of gold and silver coin imported.

## MINES REPORT.

### METHOD OF COLLECTING STATISTICS.

The first table in this report presents the final official figures of the production of gold and silver in the United States in 1911 as agreed upon by the Bureau of the Mint and the United States Geological Survey. With the relatively unimportant exceptions of domestic gold and silver contained in ores, mattes, etc., exported for reduction during the year, these figures record the actual production of gold and silver bullion from domestic ores in marketable form as metals, either refined or unrefined.

Owing to the difficulty of tracing this total gold and silver production back to its origin by States, counties, and mining districts, however, the Geological Survey attacks the problem of distribution by systematic investigation of the mine production of ores containing gold and silver during the calendar year, and of the output of the placer mines. In this way the state of the mining industry is studied in detail, and classification of output by methods of production and by kinds of ore, as well as by mining districts, is obtained. The resulting figures form the basis of the mines report.

As already stated, the Bureau of the Mint takes into account, as the basis for figures of production, statistics of gold and silver in unrefined bullion deposited in the United States mints and assay offices, in fine bars of both metals produced by private refineries, and in ores, mattes, etc., exported for treatment.

The data for the mines report of the United States Geological Survey may be classified as follows: (1) Gold and silver from placers in nuggets, dust, and bullion; (2) gold and silver in mill bullion (obtained by amalgamation, cyanidation, chlorination, etc.) from mills of mine companies treating their own ores, tailings, dumps, etc.; (3) gold and silver in base bullion, matte, etc. (by assay value), from smelters treating their own ores; and (4) gold and silver in crude ore, concentrates, old tailings, slags, etc. (by assay value), shipped to custom mills and smelters—all four of these classes of data being for

material treated at the mines or shipped from them during the calendar year.

The first item is the native gold (with silver in natural alloy) produced from placer mines and sold to Government mints and assay offices, and to refineries, banks, and traders. It is difficult to obtain accurate figures for this item only in some parts of Alaska, or from transitory miners elsewhere, or from miners who report only value received for their output. The second and third items cover metal production by mining companies whose mills and smelters treat their own ores and whose products go to the mints and refineries and are covered by confidential mine reports to the Survey. The fourth item, which covers raw mine products shipped for treatment, gives rise to the main apparent discrepancies between mine and mint-refinery reports on the production of gold and silver for the same calendar year. The discrepancies are due largely to the lapse of time between the disposal by shipment of the ore as reported from the mines and its arrival and metallurgical treatment at the mills or smelters, followed by the refining of the products, an interval in which large quantities of metals in ores reported from the mines as shipped in one year may be reported from refineries as produced in marketable form in the following year. For instance, ore shipped in November may be smelted in the following January, and the metal content would be reported from the mines for the calendar year preceding that for which it would be reported in marketable form by the smelters and refineries. The miners furnish the United States Geological Survey with confidential reports on assay values and tonnages of ore and concentrates shipped as the measure of their output, and the mine figures are reported by the Survey so far as possible in terms of recoverable metal; and the smelters and refineries report the metals eventually produced, first as unrefined and finally as refined.

In using the mines report it should be noted that tonnages and metal output given are based not on ore mined but on ore treated or sold during the year. Of course most of the ore treated or sold is also mined during the same year, but some of it is necessarily mined during the preceding year. It must not be overlooked also that the mines report aims to give the recoverable content, not the assay content, of ore treated or sold. A part of the actual recovery is of course made during the early part of the following year for ores treated or sold late in the year under review, but the basis of the report is essentially metal recovered at whatever time from the tonnage treated or sold during the year covered by the report. For the second and third items enumerated the recovery figures are easily had, as the ore is treated on the ground, and the metal content of the bullion, either base or unrefined, is readily known. In the third item the refining loss and in the fourth item the combined concentrating, smelting, and refining losses must be considered. In the case of the precious metals the concentrating losses may be large and must be allowed for, but the smelting and refining losses are known to be very small and in ordinary practice to be more than offset by certain gains. These gains are of small quantities of precious metals (not paid for, but actually recovered from ores of copper, lead, and zinc) and certain differences in quantity of gold and silver between actual recovery and basis of settlement—for

instance, silver is usually paid for on the basis of 95 per cent of the current New York price and gold at from $19 to $20 per fine ounce. From this it is seen that producers reporting in terms of dollars only will frequently be giving figures corresponding to production below actual final output of metal, and if they erroneously report net proceeds, as they sometimes do, their figures are still further below. Other gains offsetting refining and smelting losses are the relatively small quantities of precious metals, principally gold, not regularly reported from the mines, but coming from transitory placer miners whose production escapes estimate, from stolen ore treated in improvised "assay offices," and from smelter and refinery cleanings and similar material. Although mine reports in the aggregate may appear, therefore, to give figures of gold and silver that are too high, it is known from actual practice and comparison, later discussed, that final recoveries, especially for gold, are somewhat in excess of those reported from the mines.

## COMPARISON OF MINT REPORT AND MINES REPORT.

Of the two plans outlined for ascertaining the gold and silver production of the United States it may be said that the one is a measure of the mining industry and the other a measure of the metallurgical industry; the one reports the production and recoverable content of mine output and the other the metal actually recovered in marketable form. The two methods will not produce exactly corresponding results nor should they be expected to do so. In addition to factors already noted as causing differences between the two sets of figures, it must be remembered that it is not always a simple matter for smelters to distribute their output according to the exact origin of the ore, and it is still more difficult for refiners to do so. It is therefore always possible that some ore of Canadian or Mexican origin is contributing to the output of metal thought by smelters to be of domestic origin.

The calendar year covered by both investigations is the same but the period of mine production naturally corresponds to a period earlier than the period of actual production of marketable metal by the interval of time necessary for transporting, sampling, and treating the ore and for refining the products. This interval is practically negligible in the case of placer and mill bullion, but may be several months in the case of crude smelting ores and especially of ores concentrated before smelting.

The figures for the mint report and the mines report for a period of years sufficiently long to compensate for overlap or lag should agree within allowable limits of error due to the complex nature of the ores and of the methods of treatment. The figures of the mines report may be expected, on the whole, to fall normally below those of the mint report for the reasons outlined.

For the last seven years the final figures for mint and mine returns have been as follows:

*Production of gold and silver, 1905–1911, according to mint and to mine returns.*

| Years. | Mint. | | Mine. | |
|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. |
| | | *Ounces.* | | *Ounces.* |
| 1905 | $88,180,700 | 56,101,600 | $88,159,881 | 56,272,496 |
| 1906 | 94,373,800 | 56,517,900 | 97,219,645 | 57,362,455 |
| 1907 | 90,435,700 | 56,514,700 | 87,471,136 | 52,500,104 |
| 1908 | 94,560,000 | 52,440,800 | 91,914,891 | 50,878,140 |
| 1909 | 99,673,000 | 54,721,500 | 99,438,144 | 57,315,677 |
| 1910 | 96,269,100 | 57,137,900 | 94,933,778 | 57,598,509 |
| 1911 | 96,890,000 | 60,399,400 | 97,054,791 | 61,108,791 |
| Total | 660,382,300 | 393,833,800 | 656,192,266 | 393,036,172 |

These figures show an excess of gold, according to mint reports, for the seven years of $4,190,034, or a difference of a little over 0.6 per cent, and a corresponding excess of silver production of 797,628 fine ounces, or a difference of less than 0.02 per cent. As figures for Alaska placers are not claimed to be as close as these, the differences for the United States proper are even lower. It is thought these relatively small differences may be accounted for by the explanations already given. For figures of any one year an excess of mining over smelting and refining, whether of gold and silver or of base metal ore, or both, is indicated by larger figures in the mine reports for gold or silver, or both; and normal relations, or perhaps excess of smelting and refining over mining by drawing upon stocks, is suggested by the reverse figures.

## UNITS OF MEASUREMENTS.

Gold and silver are measured by the fine ounce. The computing tables to six decimals used by the Bureau of the Mint and the United States Geological Survey are based on the exact valuation for gold of $20.671834625323 per fine ounce. The average commercial price in New York for silver per fine ounce in 1910 was taken at 54 cents and in 1911 at 53 cents. The standard Survey unit for ore production is the short ton of 2,000 pounds.

## PRODUCTION OF GOLD AND SILVER REPORTED FROM THE MINES.

The following table gives the quantity and value of gold and silver by States reported from the producing mines in 1911 to the United States Geological Survey. The increase or decrease of production shown results from comparison with the corresponding Survey mine figures for 1910.

*Mine production of gold and silver in the United States in 1911 as reported to the United States Geological Survey, by States and Territories, in fine ounces.*

| State or Territory. | Gold. | | Silver. | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Gold, value. | Silver, quantity. |
| Alabama | 915.06 | $18,916 | 171 | $91 | − $14,617 | − 97 |
| Alaska | 815,276.26 | 16,853,256 | 460,231 | 243,922 | + 726,507 | + 302,381 |
| Arizona | 165,950.58 | 3,430,503 | 3,276,571 | 1,736,583 | + 281,137 | + 710,043 |
| California | 954,869.67 | 19,738,908 | 1,270,445 | 673,336 | + 23,468 | − 569,640 |
| Colorado | 919,220.54 | 19,001,975 | 7,330,168 | 3,884,989 | −1,505,083 | −1,179,430 |
| Georgia | 1,696.51 | 35,070 | 212 | 112 | − 532 | − 123 |
| Idaho | 66,389.22 | 1,372,387 | 8,196,136 | 4,343,952 | + 275,545 | + 826,394 |
| Illinois | | | 3,036 | 1,609 | | + 1,014 |
| Kentucky | | | | | | − 84 |
| Maryland, New Hampshire, and Pennsylvania | .44 | 9 | 87 | 46 | − 6,008 | − 439 |
| Michigan | | | 497,281 | 263,559 | | + 166,781 |
| Missouri | | | 49,867 | 26,429 | | + 16,771 |
| Montana | 179,498.87 | 3,710,571 | 11,985,196 | 6,352,154 | − 19,915 | − 177,661 |
| Nevada | 880,105.58 | 18,193,397 | 13,184,601 | 6,987,839 | − 685,467 | + 704,730 |
| New Mexico | 36,900.84 | 762,808 | 1,354,540 | 717,906 | + 280,384 | + 510,553 |
| North Carolina | 3,399.89 | 70,282 | 943 | 500 | + 2,237 | − 8,110 |
| Oregon | 30,641.06 | 633,407 | 45,221 | 23,967 | − 46,081 | + 9,243 |
| Philippines | 9,300.00 | 192,248 | 900 | 477 | + 37,818 | − 900 |
| Porto Rico | 105.99 | 2,191 | 51 | 27 | + 1,191 | + 51 |
| South Carolina | 987.24 | 20,408 | 11 | 6 | − 17,916 | − 35 |
| South Dakota | 359,903.90 | 7,439,874 | 203,755 | 107,990 | +2,037,617 | + 84,955 |
| Tennessee | 562.17 | 11,621 | 106,660 | 56,530 | + 8,508 | + 25,421 |
| Texas | 1.02 | 21 | 424,394 | 224,929 | − 402 | + 44,072 |
| Utah | 227,217.28 | 4,696,998 | 12,473,787 | 6,611,107 | + 664,913 | +2,006,816 |
| Virginia | 148.22 | 3,064 | 21 | 11 | + 2,176 | − 107 |
| Washington | 41,006.37 | 847,677 | 243,781 | 129,204 | + 59,532 | + 38,436 |
| Wyoming | 928.80 | 19,200 | 725 | 384 | + 16,001 | − 753 |
| Total | 4,695,025.51 | 97,054,791 | 61,108,791 | 32,387,659 | +2,121,013 | +3,510,282 |

An increase in production of gold amounting to $2,121,013 and an increase in silver output of 3,510,282 fine ounces are shown by the mines report for the United States for 1911, as compared with the corresponding figures for 1910.

The principal producing States ranked as follows in 1911 in output of gold: California, Colorado, Nevada, Alaska, South Dakota, Utah, Montana, Arizona, and Idaho, or the same as in 1910, except that a large decrease in Colorado and a small increase in California brought the latter State to the head of the list in 1911, exchanging places with Colorado, which led all the States in 1910. No other State besides the 9 mentioned above produced $1,000,000 in gold during the last two years. The most notable increases in 1911 were $2,037,617 in South Dakota, $726,507 in Alaska, and $664,913 in Utah. The heaviest decreases were $1,505,083 in Colorado and $685,467 in Nevada. Of the 23 States and State groups, Territories, and insular possessions enumerated in the table, gold production increased in 14 and decreased in 9 in 1911.

In silver output the principal producing States ranked as follows: Nevada, Utah, Montana, Idaho, Colorado, Arizona, New Mexico, and California. Changes in relative rank in 1911 from 1910 were that Utah changed places with Montana, Idaho with Colorado, and New Mexico took rank between Arizona and California. No other States than those mentioned produced 1,000,000 ounces of silver in 1910 or 1911, and New Mexico fell below that mark in 1910. The largest

increases in silver production in 1911 were 2,006,816 ounces in Utah, 826,394 ounces in Idaho, 710,043 ounces in Arizona, 704,730 ounces in Nevada, and 510,553 ounces in New Mexico. The most notable decreases were 1,179,430 ounces in Colorado and 569,640 ounces in California. Of 27 geographic divisions enumerated in the table, increased production of silver in 1911 is noted for 15 and decreased output for the remaining 12.

The following tables show the relative rank and locations of the 16 mines or groups making the largest production of gold and of silver in the United States in 1911. Figures for individual output can not be given, although companies operating some of the mines publish annual reports giving these and many other interesting data, and notes have been published by the Survey and in the technical and scientific press descriptive of most of the mines:

*The 16 mines in the United States having the largest production of gold in 1911, by rank.*

| Rank. | Mine. | Location. | State. |
|---|---|---|---|
| 1 | Goldfield Consolidated | Goldfield | Nevada. |
| 2 | Homestake | Lead | South Dakota. |
| 3 | Alaska-Treadwell | Juneau | Alaska. |
| 4 | Camp Bird | Sneffels | Colorado. |
| 5 | Golden Cycle | Cripple Creek | Do. |
| 6 | Liberty Bell | Telluride | Do. |
| 7 | Portland | Cripple Creek | Do. |
| 8 | Ready Bullion | Juneau | Alaska. |
| 9 | North Star | Grass Valley | California. |
| 10 | Tonopah Mining Co | Tonopah | Nevada. |
| 11 | Tonopah Belmont | do | Do. |
| 12 | Utah Consolidated [a] | Bingham | Utah. |
| 13 | Vindicator | Cripple Creek | Colorado. |
| 14 | Kennedy | Amador City | California. |
| 15 | National | National | Nevada. |
| 16 | Tom Reed | Kingman | Arizona. |

[a] Copper mines.

*The 16 mines in the United States having the largest production of silver in 1911, by rank.*

| Rank. | Mine. | Location. | State. |
|---|---|---|---|
| 1 | Anaconda mines [a] | Butte | Montana. |
| 2 | Tonopah Belmont | Tonopah | Nevada. |
| 3 | Tonopah Mining Co | do | Do. |
| 4 | Iron Blossom | Eureka | Utah. |
| 5 | Mace and Burke [c] | Wallace | Idaho. |
| 6 | Silver King [c] | Park City | Utah. |
| 7 | Speculator [b] | Butte | Montana. |
| 8 | Copper Queen [b] | Bisbee | Arizona. |
| 9 | Bunker Hill and Sullivan [c] | Yreka | Idaho. |
| 10 | Centennial-Eureka | Eureka | Utah. |
| 11 | Daly West [c] | Park City | Do. |
| 12 | Hercules [c] | Burke | Idaho. |
| 13 | Montana Tonopah | Tonopah | Nevada. |
| 14 | Old Jordan-Telegraph [c] | Bingham | Utah. |
| 15 | Holter (Elkhorn) [c] | Jefferson City | Montana. |
| 16 | Tonopah Extension | Tonopah | Nevada. |

[a] From all Butte mines of Anaconda Copper Co
[b] Copper mines.
[c] Lead mines.

## MINE PRODUCTION OF GOLD AND SILVER, BY STATES.

### ALASKA.

*Gold.*—The gold production of Alaska in 1911 was $16,853,256, against $16,126,749 in 1910. The output from siliceous ores was $4,226,687, against $4,105,459 in 1910, and that from copper ores was $86,569, against $36,484 in 1910. The production from placers also increased from $11,984,806 in 1910 to $12,540,000 in 1911.

From the Pacific coast belt, including southeastern Alaska and Prince William Sound, the output of gold in 1911 was $4,265,573, against $4,182,730 in 1910; from the Copper River and Cook Inlet regions, $313,538, against $351,630; from the Yukon and Kuskokwim basins, $9,139,145, against $8,062,389; and from Seward Peninsula and northwestern Alaska, $3,135,000, against $3,530,000. From the first and third of the above-named geographic divisions there were increases in output therefore of $82,843 and $1,076,756, respectively, and from the second and fourth decreases of $38,092 and $395,000, respectively, giving a net increase for Alaska for the year of $726,507. The increased gold output of Alaska in 1911 was due mainly to materially greater placer output from the Innoko-Iditarod region and the Hot Springs district, and also to much greater output of copper ores. The gold production from both the Fairbanks and the Seward Peninsula placers was less than those of 1910.

About three-fourths of the gold production still comes from the placers, but the tendency is for the relative output from the deep mines to increase and for the production from the gravels themselves to be less subject to fluctuation, owing to the prospect for increased production from dredges. The auriferous lode mines of southeastern Alaska produced $3,904,217 in gold in 1911, against $3,839,626 in 1910. The great Treadwell low-grade gold mines of the Juneau district continued to be the heaviest producers. In the Copper River region the Bonanza copper mine was actively developed and made important production. The Fairbanks camp, in the Yukon basin, continued to lead all other placer gold districts in Alaska in production, but the output decreased from $6,100,000 in 1910 to $4,500,000 in 1911. The production of the gravels of the Hot Springs district in the Yukon is estimated at $785,000 in 1911, a large increase over that of 1910; and the production of the Innoko-Iditarod region of the Yukon basin increased from $825,000 in 1910 to approximately $3,000,000 in 1911. Seward Peninsula is estimated to have produced about $3,100,000 in gold in 1911, against $3,530,000 in 1910. Twenty-four dredges in all were operated in Seward Peninsula in 1911, against 16 in 1910. Dredging has become of greatly increasing importance here in recent years.

*Silver.*—The production of silver in Alaska was 460,231 fine ounces in 1911, against 157,850 ounces in 1910. Of the total production 320,114 ounces was obtained from copper ores, 110,288 ounces from placer gold, and the small remainder from siliceous ores of the lode gold mines.

### ARIZONA.

*Gold.*—The gold production of Arizona in 1911 was $3,430,503, against $3,149,366 in 1910 and $2,737,500 in 1909. This was the largest gold output of recent years, and the increase was due largely to

increased output from siliceous gold ores in Mohave County and from copper ores in Cochise County. In total production of gold in Arizona in 1911 Mohave County led, with $1,547,663, mainly from siliceous gold ores of the Gold Road and Tom Reed mines of the San Francisco district. Cochise County ranked second, with $783,-981, mainly from copper ores of the Warren (Bisbee) district, but also in part from lead ores and dry or siliceous ores. Yavapai County ranked third, with $689,684, almost equally from copper ores of the Verde district and dry or siliceous ores of the Martinez district and other districts. Yuma County was fourth in gold output, with $207,058 largely from the siliceous ores of the Kofa district. The amalgamation process yielded $234,555 in gold in Arizona in 1911; the cyanidation process (from ore and old tailings), $1,680,124; the placers, mainly in Yavapai, Yuma, and Pima counties, $23,641; and the smelting ores the remainder of the gold production, or $1,492,183.

*Silver.*—The output of silver in Arizona in 1911 was 3,276,571 fine ounces, against 2,566,528 ounces in 1910 and 2,601,161 ounces in 1909. Cochise County had the largest yield, and made the greatest increase in 1911, producing 1,946,319 ounces, mainly from copper ores of the Warren district, but also in considerable quantity from lead ores of the Tombstone, Warren, and other districts. Yavapai County ranked second in the silver output, with 764,744 ounces, mainly from copper ores of the Verde district, and dry or siliceous ores. Gila County was third, with 247,813 ounces, chiefly from copper ores of Globe. Mohave County produced 143,969 ounces, and Greenlee County 104,429 ounces. Of the total silver output of Arizona in 1911 copper ores supplied 2,136,121 ounces; lead ores, 635,363 ounces; dry or siliceous ores, 414,981 ounces; and the lead-zinc and zinc ores nearly equal parts of the bulk of the small remainder.

## CALIFORNIA.

*Gold.*—The mine production of gold in California in 1911 was $19,738,908, an increase of $23,468 over the output of 1910. The total placer production increased, but the deep-mine output fell off somewhat, owing to decreased copper and lead mining. The production from gold-quartz mining, however, increased even more than that from placers. In placer output that from dredging and hydraulic mining increased, while that from drift mining and sluicing fell off, the changes being in the same direction as in 1910.

The total output of gold from dredging in California continued to increase somewhat in 1911, the production from this source being $7,666,461, again the largest in the history of the industry. The increase in output was mainly from Sacramento, Yuba, Calaveras, Placer, and smaller dredging counties, as the production from the great Butte County field and the smaller Siskiyou field has fallen off. The total gold production from dredging in California from 1899 (when the output from this source began and was only $206,302) to 1911, inclusive, has been $47,985,236. The production has increased every year but two, although the rate of increase in recent years has steadily declined. The dredges produced 85.32 per cent of the total placer gold, and 38.84 per cent of the total gold from all sources in California in 1911.

Placer-gold production from all sources in California in 1911 was $8,986,527, against $8,888,795 in 1910. Of the placer output for 1911, $675,486 was derived from 169 hydraulic mines, $7,666,461 from 65 dredges, $479,900 from 141 drift mines, and $164,680 from 210 surface or sluicing mines.

The total gold output from California deep mines in 1911, was $10,752,381, against $10,826,645 in 1910. Of this total $10,317,794 came from siliceous or gold-quartz ores; $427,789 was derived from the smelting of copper ores; and $6,798 was from silver-lead ores.

By counties, the largest gold increases in 1911 were, $477,858 from Tuolumne, whose output is mainly from deep mines on the Mother Lode; $415,952 from Sacramento, in which is the important Folsom dredging field; $186,149 from Amador, another Mother Lode county; $166,436 from Inyo; $149,478 from Sierra; and $142,306 from Trinity. The largest decreases were, $413,134 from Shasta, due mainly to copper-smelting difficulties; $334,336 from Nevada, from both deep and placer mines; $207,201 from Yuba, mainly from the dredging fields; $174,492 from Mono; $164,395 from Butte, mainly from dredging; and $145,048 from Mariposa, on the Mother Lode. Counties producing over $1,000,000 in gold in California in 1911 were Yuba, with $2,997,072; Amador, with $2,832,395; Butte, with $2,323,396; Nevada, with $2,199,147; Sacramento, with $1,812,826; Calaveras, with $1,112,315; Tuolumne, with $1,093,484; and Shasta, with $1,059,881. Of these Yuba, Butte, and Sacramento are essentially producers from dredging; Amador, Calaveras, and Tuolumne are Mother Lode counties; Nevada County production is mainly from the gold-quartz ores of the Grass Valley district; and Shasta County produces mainly from siliceous and copper ores.

The five Mother Lode counties—Amador, Calaveras, Eldorado, Mariposa, and Tuolumne—whose ores are mostly gold quartz, produced altogether in 1911 gold valued at $4,877,651, against $4,408,990 in 1910 and $4,821,416 in 1909. The average total gold and silver recovery per ton from Mother Lode ores in 1911 was $3.57, against $3.78 in 1910.

*Silver.*—The production of silver in California in 1911 was 1,270,445 fine ounces, against 1,840,085 fine ounces in 1910, a decrease of 569,640 ounces. Of this output the larger part, or 864,397 fine ounces, were recovered in refining copper produced from California ores. Siliceous ores (mainly gold quartz) milled and smelted, yielded 291,896 fine ounces, and from smelting of silver-lead ores was derived 74,611 ounces. From refining gold bullion from placers 39,541 fine ounces of silver were obtained. The copper mines of Shasta County produced 706,445 fine ounces of silver in 1911, against 1,192,520 ounces in 1910, and those of Calaveras County 107,987 ounces in 1911, against 144,683 ounces in 1910. Restricted copper mining and smelting in Shasta County, owing to litigation over the smelter-fume question, was the main cause of reduced silver yield in the State. Inyo County produced 56,089 ounces of silver from silver-lead ores, and Mono, San Bernardino, Amador, Nevada, Inyo, Tuolumne, and Shasta counties each produced over 20,000 ounces from siliceous ores in 1911. Although the greater part of the silver output of California is derived from copper and gold ores, there were 11 silver and 33 silver-lead mines producing in California in 1911, mainly in Inyo and San Bernardino counties.

## COLORADO.

*Gold.*—In 1911 the production of gold was $19,001,975, a decrease of $1,505,083 from the output for 1910, and of $2,987,361 from that of 1909. The production of Cripple Creek, which was $10,562,653 in 1911, decreased $439,600, following a decrease of $468,420 in 1910. The output of Ouray County fell off $242,889 in 1911, following a decrease of $848,978 in 1910. In addition to the above decreases from Teller and Ouray counties, notable decreases were also recorded from San Juan, Park, and La Plata counties, and smaller decreases from Gunnison, Summit, Lake, Chaffee, Clear Creek, Custer, Dolores, San Miguel, and Pitkin counties in 1911. The output of Mineral County showed a considerable increase, and smaller increases are noted from Gilpin, Boulder, Costilla, and Eagle counties.

The chief gold-producing counties of Colorado, with their outputs for 1911, were: Teller (Cripple Creek), $10,562,653; San Miguel, $2,447,841; Ouray, $1,952,958; Lake (Leadville), $1,133,442; Gilpin, $778,774; Clear Creek, $519,207; San Juan, $336,463; La Plata, $286,937; and Summit, $284,241. No other county produced $250,000 in 1911. The San Juan region, including San Juan, San Miguel, Ouray, Dolores, Hinsdale, Montezuma, and La Plata counties, in southwestern Colorado, produced altogether $5,035,610 in 1911, against $5,822,422 in 1910 and $6,170,201 in 1909. The Clear Creek region, including Boulder, Clear Creek, and Gilpin counties in north-central Colorado, produced $1,461,155 in gold in 1911, against $1,350,337 in 1910 and $1,586,991 in 1909.

Of the total ore mined and sold or treated, dry or siliceous ores made up 79 per cent and yielded $17,907,034 of the gold, or 94 per cent of the total gold output; nearly 2 per cent came from the placers, and nearly 2 per cent from lead ores, the remainder of the gold production being derived from copper, zinc, and lead-zinc ores. The total placer output of Colorado in 1911 was $319,759, a decrease of $75,706. Summit County, with 3 dredges and 9 placers, mainly in the Breckenridge district, yielded nearly 81 per cent of the placer output. The greater part of the remainder came from sluicing operations in Park County and a dredge in Costilla County.

*Silver.*—The silver production of Colorado in 1911 was 7,330,168 fine ounces, against 8,509,598 ounces in 1910 and 8,902,633 ounces in 1909. Lake County (Leadville) showed a decrease of 314,719 ounces, following a decrease of 101,627 ounces in 1910, but yielded 41 per cent of the State output in 1911, against 39 per cent in 1910 and 38 per cent in 1909. Decreased production is also recorded for La Plata, Mineral, San Juan, and San Miguel counties, but notable increases were made in Eagle, Gilpin, Ouray, and Summit counties.

The silver production of the leading counties in Colorado in 1911 was as follows: Lake, 3,007,296 ounces; San Miguel, 1,000,834 ounces; Mineral, 545,319 ounces; Ouray, 512,800 ounces; Pitkin, 450,772 ounces; Clear Creek, 437,841 ounces; and San Juan, 325,604 ounces. No other county produced 300,000 ounces of silver in 1911. The San Juan region produced 1,972,637 ounces in 1911, against 2,625,033 ounces in 1910, and 2,737,239 ounces in 1909.

Dry or siliceous ores yielded 5,096,026 fine ounces of silver in 1911, or nearly 70 per cent of the total output; lead ores, 1,265,594 ounces, or 17 per cent; lead-zinc ores 476,049 ounces, or 6 per cent; copper

ores, 342,550 ounces, or nearly 5 per cent; and the small remainder came from copper-lead and zinc ores.

### IDAHO.

*Gold.*—The gold production of Idaho in 1911 was $1,372,387, against $1,096,842 in 1910. The output from 152 deep mines in 1911 was $968,060, largely from Owyhee and Elmore counties, and the production from 217 placers was $404,327, principally from 7 dredges, but nearly one-third of the placer output also came from 204 sluicing or hydraulicking operations. Siliceous ore supplied 57.30 per cent of the gold output, placers 29.46 per cent, copper ores 6.76 per cent, and lead ores 5.78 per cent. Two new dredges, one at Idaho City, with a rated capacity of 8,000 cubic yards per day, and the other near Salmon, with a capacity of 5,000 yards, contributed to the increased output of gold. Boise County produced $265,767, a large increase, from placers in 1911 and $87,697 from deep mines. Elmore County produced $3,546 from placers and $234,741 from deep mines. Owyhee County produced $1,368 from placers and $320,835 from deep mines. The Boise Basin region, in Boise County, whose output is largely from placers, including dredges, produced $328,838 in gold in 1911, against $168,051 in 1910 and $127,954 in 1909.

*Silver.*—The silver output of Idaho increased from 7,369,742 fine ounces in 1910 to 8,196,136 ounces in 1911. Over 86 per cent of the silver output of Idaho is from the lead mines, especially of the Coeur d'Alene, in Shoshone County; and as production of lead ores largely increased, that of silver did also. The silver output from lead and lead-zinc concentrates was 5,221,406 ounces in 1911, and crude ore shipped to smelters contained 2,689,807 ounces. Of the small remainder of the silver production, 13,753 ounces were recovered by amalgamation and 266,319 ounces by cyanidation.

### MICHIGAN.

*Silver.*—The Michigan copper mines produced 497,281 fine ounces of silver in 1911, against 330,500 ounces in 1910. The silver production is mainly from the electrolytic refining of the copper produced, and, as refining may proceed at a different rate from mining, increased output of silver in general indicates only increased quantity of copper refined. The average recovery per ton of "rock" (both conglomerate and amygdaloid) was 0.04 ounce in 1911, against 0.03 ounce in 1910. Of the total output in 1911, Houghton County supplied 459,715 ounces, Keweenaw County 37,053 ounces, and Ontonagon County 513 ounces. The increased production was almost wholly from Houghton County.

### MISSOURI, ILLINOIS, AND KENTUCKY.

*Silver.*—The lead and zinc mines of the Central States contribute no gold and but little silver as a by-product. The small production is mainly from the lead ores of southeastern Missouri, where the silver content is only about 1 ounce per ton of concentrates saved, and lead from only about one-sixth of these ores is desilverized. The output of silver in Missouri in 1911 was 49,867 fine ounces from 51,109 short

tons of silver-bearing lead concentrates, against 33,096 fine ounces in 1910 from 35,002 tons of concentrates.

In Illinois the silver output in 1911 was 3,036 fine ounces from 482 short tons of silver-bearing lead concentrates (recovered from lead-zinc-fluorspar ores), against 2,022 ounces from 398 tons of concentrates in 1910.

In western Kentucky silver is a by-product from lead-zinc-fluorspar ores of the Kentucky-Illinois field, but there was no output of silver reported for 1911, against a recovery of 84 fine ounces from 56 tons of lead concentrates in 1910.

### MONTANA.

*Gold.*—The production of gold in Montana was $3,710,571 in 1911, a decrease of $19,915 from $3,730,486 in 1910, and of $80,939 from the production of 1909. The production from placers increased; that from dry or siliceous ores fell off; that from copper ores remained about as in 1910; and that from lead and zinc ores decreased. By amalgamation were recovered 12,643 fine ounces of gold in Montana in 1911, by cyanidation 43,104 ounces, from placers 33,127 ounces, and the remainder, or 90,625 ounces, by smelting ores and concentrates, dry or siliceous, copper, lead, and zinc. Madison County led in gold production, with $860,389, of which $584,948 was from placers, operated chiefly by dredges, in the Alder Gulch district. Broadwater County ranked second with $605,642, mainly from auriferous pyrite ores and oxidized iron ores of the Cedar Plains district. Chouteau County ranked third with $433,836, chiefly from the Little Rockies.

*Silver.*—The silver output of Montana in 1911 was 11,985,196 fine ounces, against 12,162,857 ounces in 1910, and 12,378,714 ounces in 1909. The copper ores alone, mainly from Butte, in Silver Bow County, produced 9,597,752 ounces in 1911 and 9,153,590 ounces in 1910. The dry or siliceous ores supplied 1,613,253 ounces, chiefly from Jefferson, Granite, and Silver Bow counties; the zinc ores supplied 491,161 ounces, all from Butte in Silver Bow County, and the lead ores 186,926 ounces. In State output of silver Silver Bow County led with 10,258,122 ounces in 1911, followed by Jefferson with 823,704 ounces, and Granite with 350,852 ounces. The principal silver-producing districts in these counties are Butte, Elkhorn, and Flint Creek.

### NEVADA.

*Gold.*—The production of gold in Nevada in 1911 was $18,193,397, against $18,878,864 in 1910. The largest decreases were of $850,075 from the Goldfield district and of $234,772 from the National district; but these were in part offset by increases from other sections, such as that of $474,506 from Storey County (the Comstock). The great bulk of the gold output came as usual from dry or siliceous ores and their concentrates, the small remainder being derived almost wholly from copper ores, placer gravels, and lead ores, in the order given. The siliceous ores were produced mainly in Esmeralda County, where Goldfield is the chief district; in Nye County, in which are the Tonopah mines; in Humboldt County, which includes the new camp of National; and in Storey County, in which is the Comstock. The

production from copper ores was mainly from the Robinson or Ely district, of White Pine County, and that from placers chiefly from Manhattan and Round Mountain districts in Nye County.

In county production of gold Esmeralda led with $11,198,602, against $11,994,338 in 1910, of which the great Goldfield camp produced $10,287,075 in 1911 and $11,137,150 in 1910. Nye County followed with $3,617,276 in gold in 1911, against $3,661,967 in 1910, of which Tonopah produced $2,366,495 in 1911, against $2,303,702 in 1910. Humboldt County was third in gold output, with $1,223,714 in gold in 1911, against $1,458,486 in 1910, the chief part of which was from the National district.

*Silver.*—The silver output of Nevada in 1911 was 13,184,601 fine ounces, against 12,479,871 ounces in 1910 and 10,981,061 ounces in 1909. Of the total production Nye County supplied 10,918,263 ounces in 1911, against 10,550,303 ounces in 1910, mainly from the siliceous silver-gold ores of Tonopah. Storey County produced 618,006 ounces of silver in 1911, from the siliceous ores of the Comstock; Churchill County 456,066 ounces, mainly from dry or siliceous ores of Fairview district; and Humboldt County produced 255,367 ounces, mainly from the National district.

### MARYLAND, NEW HAMPSHIRE, AND PENNSYLVANIA.

*Gold and silver.*—In Maryland a small output of copper concentrates from the New London mine resulted in a nominal production of gold and silver in 1911, figures for which have been combined with those of Pennsylvania to avoid disclosing individual output.

There was no output of gold and silver from copper-pyrite ores of New Hampshire in 1911, although there was a small production in 1910.

In Pennsylvania there is annually an interesting but insignificant production of silver and gold as by-products from refining copper produced from pyritic concentrates. These are obtained by separation by the Gröndahl process, from the well-known magnetite iron ores of Cornwall, in Lebanon County. The output of Maryland and Pennsylvania combined for 1911 was $9 in gold and 87 fine ounces of silver.

### NEW MEXICO.

*Gold.*—The gold production of New Mexico was $762,808 in 1911, against $482,424 in 1910. Socorro County alone produced $534,253 in 1911, almost wholly from the siliceous ores of the Mogollon. Grant County produced $116,284 in 1911, Colfax County $41,407, Lincoln County $31,934, and Sierra County $27,785. Siliceous ores from the entire State produced over 89 per cent of the total gold output, copper ores (chiefly from Grant County) about 8 per cent, and placers about 2.5 per cent. Smelters within the State were idle in 1911, the shipping ore going to El Paso and Arizona. The notable feature for the year was increased use of cyanidation for the gold ores of the Mogollon district and elsewhere.

*Silver.*—The output of silver in New Mexico in 1911 was 1,354,540 fine ounces, against 843,987 ounces in 1910. Socorro County alone produced 1,109,945 ounces, or 82 per cent of the total, chiefly from siliceous ores of the Mogollon district. Grant County supplied 221,882

fine ounces, or 16 per cent, chiefly from siliceous, copper, and lead ores. Notwithstanding greatly increased development and output of ore from the Chino mines of Santa Rita, in Grant County, the relative output of silver from copper ores will not considerably increase, as the tenor of silver in these ores is exceptionally low.

### OREGON.

*Gold.*—The gold production of Oregon in 1911 was $633,407, against $679,488 in 1910, a decrease of $46,081. Baker County again led in output of gold, with a production of $389,768, against $401,002 in 1910. Josephine County was second, with $99,363 in 1911, against $150,048 in 1910. The total placer production was $168,274, of which Josephine County produced $86,557 and Jackson County $25,740. Of the gold output from deep mines, Baker County produced $372,405, Lane County $30,154, Grant County $25,492, and Jackson County $20,787. Three dredges in Oregon produced $14,575 in 1911, against an output of $34,010 from 6 dredges in 1910. The gold production of the State decreased both from placer and from gold-quartz mines. Southwestern Oregon produced $188,971 in gold in 1911, against $209,324 in 1910, and of these amounts the placers produced $123,008 in 1911, against $130,103 in 1910. Northeastern Oregon produced $444,436 in 1911, against $470,164 in 1910, and of these amounts the deep mines produced $399,170 in 1911, against $429,342 in 1910.

*Silver.*—The silver output of Oregon in 1911 was 45,221 fine ounces, against 35,978 ounces in 1910. Of the total production, Baker County produced 30,944 ounces in 1911, against 29,835 ounces in 1910, mainly from siliceous ores. This class of ore produced 34,011 ounces in Oregon in 1911. The copper ores of Josephine County supplied 9,953 ounces, and the placers throughout the State the small remainder.

### SOUTHERN APPALACHIAN STATES.

*Gold.*—The combined gold production of Alabama, Georgia, North Carolina, South Carolina, Tennessee, and Virginia in 1911 was $159,361, against $179,505 in 1910. North Carolina maintained the lead in gold output with $70,282, followed by Georgia with $35,070, South Carolina with $20,408, and Alabama with $18,916. The output was mainly from gold-quartz ores, especially from North Carolina, and placers, mainly from Georgia.

*Silver.*—The silver output of the Southern States in 1911 was 108,105 fine ounces, against 91,069 ounces in 1910, and 63,419 ounces in 1909. Of the total production the copper ores of the Ducktown district in Tennessee furnished 106,660 ounces in 1911, the small remainder coming chiefly from gold-quartz ores, particularly of North Carolina, and from placers, mainly from Georgia.

### SOUTH DAKOTA.

*Gold.*—The production of gold in South Dakota in 1911 was $7,439,874, against $5,402,257 in 1910, and has only been exceeded by the record output of $7,657,376 of 1908. The total production of gold in South Dakota from 1875 to 1911, inclusive, has been $162,743,468. The production is almost wholly from siliceous ore

and the greater part of this is low-grade milling-amalgamation-cyaniding ore. Mining and metallurgical practice of highest grade have been characteristic of the successful operation of South Dakota gold mines, particularly of the great Homestake mines and mills of Lawrence County, which produce the bulk of the output. The operation at Mystic, Pennington County, for nearly half the year, of the first dredge in the Black Hills, was of special interest in 1911.

*Silver.*—The silver production of South Dakota, mainly from refining gold mill bullion, was 203,755 fine ounces in 1911, against 118,000 ounces in 1910.

### TEXAS.

The gold production of Texas is merely nominal and a by-product, being $21 in 1911, against $423 in 1910. The output of silver in 1911 was 424,394 fine ounces, against 380,322 ounces in 1910. This production is almost wholly from the milling of oxidized dry or siliceous ores of the Shafter district in Presidio County.

### UTAH.

*Gold.*—The gold production of Utah in 1911 was $4,696,998, against $4,032,085 in 1910, and $4,206,548 in 1909. Decreased output was made in Tooele, Utah, and eight other counties, but this was fully offset by increased production in Salt Lake and Juab counties. The net increase was due to larger output of copper ores in Salt Lake County and of siliceous ores in Juab County. Amalgamation of gold ores was practiced in Beaver, Boxelder, Garfield, Piute, and Salt Lake counties, and cyanidation in Tooele (Mercur district), Piute (Gold Mountain district), and Iron (Gold Springs district) counties. These two processes together produced $626,609 in gold in 1911, against $754,127 in 1910. The remainder of the gold output was almost entirely from the smelting of copper, lead, and dry ores and concentrates, the bulk of the total coming from copper concentrates. The leading county in gold production in Utah in 1911 was Salt Lake (chiefly Bingham district) with $2,284,934, and second in rank was Juab (mainly Tintic) with $1,500,359. Tooele followed with $584,917, chiefly from the Camp Floyd or Mercur district. The total placer output of gold in Utah in 1911 was $5,634, from Uinta, Garfield, and San Juan counties.

*Silver.*—The silver output of Utah in 1911 was 12,473,787 fine ounces, against 10,466,971 ounces in 1910 and 11,717,172 ounces in 1909. The larger part of the production was from lead-silver ore produced in Juab, Salt Lake, Summit, Utah, and Wasatch counties. In county output Juab County led with 4,673,698 ounces, mainly from dry or siliceous, lead, and copper ores, chiefly from the Tintic district. Salt Lake ranked second with 2,947,481 ounces, mainly from copper and lead ores, and chiefly from the Bingham (West Mountain) district. Third in rank was Summit County with 2,882,825 ounces, chiefly from lead ores, but also from lead-zinc and from dry or siliceous ores, mainly from the Park City region. Utah County ranked fourth, with 934,768 ounces, chiefly from lead ores of the Tintic district; Wasatch County was fifth with 545,826 ounces, from lead-zinc and lead ores, chiefly from the Park City region. Of the total silver output of Utah in 1911, produced mainly by the

smelting of crude ores and concentrates, 6,083,877 ounces came from lead ores, 2,569,157 ounces from dry or siliceous silver and gold-silver ores, 2,377,946 ounces from copper ores, and 1,358,311 ounces from lead-zinc ores.

### WASHINGTON.

*Gold.*—The gold production of Washington in 1911 was $847,677, against $788,145 in 1910 and $426,094 in 1909, and was the largest output in the last eight years. The output and increase are mainly to be credited to the Republic district, of Ferry County. This county produced $778,526 in gold in 1911, against $714,808 in 1910. The output of the Republic district alone was $772,874 in 1911, against $713,604 in 1910, and $209,114 in 1909.

*Silver.*—The silver output of Washington was 243,781 fine ounces in 1911, against 205,345 ounces in 1910. The production is mainly from siliceous smelting ores from Ferry County and copper and lead ores from Stevens County.

### WYOMING.

*Gold.*—The production of gold in Wyoming in 1911 was $19,200, against an output of $3,199 in 1910. Of this production $12,159 came from deep mines, almost entirely from siliceous ores, and $7,041 was derived from placers. The copper ores of Wyoming yielded only $257 in gold in 1911, and there was no production of lead, zinc, or mixed ores. The chief gold production of Wyoming was from 3 deep (gold-quartz) mines and 5 placers in the Atlantic City or South Pass district of Fremont County. A dredge was erected in 1911 on Bighorn River, near Shoshone, in this county.

*Silver.*—The silver production, mainly from copper ores, declined, with the decreased copper output, from 1,478 fine ounces in 1910 to 725 ounces in 1911. An interesting feature of recovery of valuable by-products from Wyoming copper ores in 1911 was the output of copper concentrates containing platinum and palladium from the Rambler mine in Albany County.

### PHILIPPINE ISLANDS.[1]

*Gold.*—The gold output of the Philippines in 1911 was $192,248, against $154,430 in 1910. The output is mainly from gold-quartz ores and from placers. Dredging in southeastern Luzon has been a source of relative importance in recent years, although the total production by dredging has been somewhat disappointing to date. The gold output of the Philippines may be expected slowly to increase from quartz mines and dredging.

*Silver.*—The silver production of the Philippines was 900 fine ounces in 1911.

### NUMBER OF PRODUCING MINES.

The following table indicates the number of mines producing gold and silver in 1911, divided into placers and deep mines. The placers are those in which gold, the silver in natural alloy with the gold, and

[1] Figures for the output of the Philippines in 1911 have been kindly furnished by the Governor General by cable through the courtesy of the Bureau of Insular Affairs, War Department.

in a few instances platinum are recovered from gravels and sands, whether by hand-washing, sluicing, hydraulicking, drifting (in frozen ground or ancient buried river channels), or dredging. The deep mines are those producing gold and silver mainly from underground workings, including those whose ores are valuable chiefly for copper, lead, or zinc, but which contribute precious metals as by-products. In addition to the producing mines here enumerated, many mines were being prospected and developed without making an output in 1911, and annual assessment work (required by law to hold claims not patented) was done on a very much greater number of new or old, worked-out, or indefinitely idle properties, once productive or otherwise, and of mere mining claims, which have not yet become "mines."

The enumeration of placer mines is less satisfactory than that of deep mines, because some of the operations are only temporary and because the production is frequently by transitory miners not regularly working placer ground. The unit, so far as possible is, however, as for deep mines, not the operator, but the mining claim, or group of claims.

*Number of producing mines in 1911, by States and Territories.*[a]

| State or Territory. | Number of mines. | | | State or Territory. | Number of mines. | | |
|---|---|---|---|---|---|---|---|
| | Placer. | Deep. | Total. | | Placer. | Deep. | Total. |
| Alabama | ..... | 2 | 2 | Oregon | 136 | 40 | 176 |
| Alaska | 740 | 26 | 766 | South Carolina | 6 | 3 | 9 |
| Arizona | 42 | 355 | 397 | South Dakota | 17 | 20 | 37 |
| California | 585 | 596 | 1,181 | Tennessee | ..... | 5 | 5 |
| Colorado | 39 | 861 | 900 | Texas | ..... | 2 | 2 |
| Georgia | 24 | 7 | 31 | Utah | 8 | 200 | 208 |
| Idaho | 217 | 157 | 374 | Virginia and New York | 5 | 10 | 15 |
| Maryland and Pennsylvania | ..... | 3 | 3 | Washington | 24 | 36 | 60 |
| Michigan[b] | ..... | 6 | 6 | Wyoming | 9 | 7 | 16 |
| Missouri[b] | ..... | 4 | 4 | | | | |
| Montana | 180 | 530 | 710 | Total | 2,146 | 3,553 | 5,699 |
| Nevada | 72 | 589 | 661 | | | | |
| New Mexico | 20 | 85 | 105 | Total 1910 | 2,026 | 3,299 | 5,325 |
| North Carolina | 22 | 9 | 31 | | | | |

[a] Illinois, Kentucky, Philippines, and Porto Rico not included.
[b] Number of mines contributing to silver production in 1911.

The table shows the number and distribution of mines producing gold and silver in the United States and Alaska. With the exception of (1) some of the Michigan copper mines, (2) all zinc mines in the Eastern and Central States and a few in the far West, and (3) all lead mines of the Central States (except a few in Illinois and southeastern Missouri), practically all mines producing copper, lead, and zinc in the United States and Alaska yield gold and silver also. The table, therefore, with these exceptions, is a table of mines producing gold, silver, copper, lead, and zinc in the United States. It also includes certain mines producing oxidized manganese-iron fluxing ores of Colorado, Utah, and elsewhere, whose ores contain small quantities of precious metals, especially silver, and are sold to western smelters as flux.

Comparisons with corresponding figures for 1910 show a net total increase of 374 producing mines in 1911. The number of deep mines increased by 254 and the number of placers by 120. In 1910 the

number of deep mines increased by 116 and the number of placers decreased by 161. In 1909 the number of deep mines increased by 319 and the number of placer mines decreased by 412. For the last six years the number of producing mines has been as follows:

*Number of mines producing gold and silver, 1906–1911.*

| Year. | Placer. | Deep. | Total. |
|---|---|---|---|
| 1906 | 2,316 | 2,114 | 4,430 |
| 1907 | 2,586 | 2,604 | 5,190 |
| 1908 | 2,599 | 2,864 | 5,463 |
| 1909 | 2,187 | 3,183 | 5,370 |
| 1910 | 2,026 | 3,299 | 5,325 |
| 1911 | 2,146 | 3,553 | 5,699 |
| Average | 2,310 | 2,936 | 5,246 |

The figures show a general decrease in number of placer mines, but a steady increase in deep mines. The enumeration of placer mines presents certain difficulties, as noted above, and it has been especially difficult in Alaska in earlier years.

In Alaska the estimate for producing placer mines was 650 in 1910 and 740 for 1911, and there were 19 deep mines producing in 1910 and 26 in 1911. In Arizona the placers decreased from 44 in 1910 to 42 in 1911, but the number of deep mines increased from 329 to 355. In California the number of placers was 564 in 1910 and 585 in 1911 and the number of deep mines was 515 in 1910 and 596 in 1911. In Colorado the number of placers decreased from 42 to 39, but the deep mines increased from 856 to 861. In Idaho the number of producing placers was 262 in 1910 and 217 in 1911 and the number of deep mines 155 in 1910 and 157 in 1911. In Montana the placers increased from 155 to 180 and the deep mines from 423 to 530. In Nevada the placers increased from 68 to 72 and the deep mines from 540 to 589. In New Mexico the placers decreased from 23 to 20 and the number of deep mines was 85 in each year. In Oregon the placers increased from 116 to 136, but the number of deep mines fell off from 64 to 40. In South Dakota the placers increased from 8 to 17 and the deep mines from 18 to 20. In Utah the number of productive placers was 8 in each year, but the number of deep mines increased from 175 in 1910 to 200 in 1911. In Washington the number of placers increased from 21 to 24, but the deep mines fell off from 55 to 36. In the Central States there are no placers and the number of deep mines remained in 1911 as in 1910. In the Eastern States the total number of placers decreased from 61 to 57 and the total number of mines producing gold and silver was 39 in each year.

## ORE PRODUCTION, CLASSIFICATION, AND AVERAGE VALUES.

The best index of deep mining is, of course, the tonnage, content, and value of ore mined, rather than the number of mines or of operators. In the next following table is given the ore production, by classes of ore and by States and Territories, of mines producing gold and silver and the average extraction value of precious metals per ton.

The classification adopted is necessarily arbitrary in part. An ore is generally understood to be worked at a profit for one or more metals.

The complex nature of western ores, especially, and the gradations from one well-recognized class to another render essential some fixed measures for the terminology used. The dry or siliceous ores comprise gold and silver ores proper, as well as fluxing ores carrying considerable quantities of iron and magnanese oxides and very small quantities of gold and silver, and precious metal bearing ores carrying copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The distinction between gold and silver ores is not here made. The total number of silver mines and the total production of true silver ores are both relatively very small. The copper ores include those containing over 2½ per cent of copper, or less than this in the cases of the great disseminated copper deposits of the West and of the Lake Superior ores; the lead ores are those containing 4½ per cent or more of lead, and the zinc ores are those containing 25 per cent or more of zinc, both irrespective of their precious metal content. The mixed ores are combinations of the ones enumerated.

*Ore production in short tons and average extraction value of gold and silver per ton in 1911, by States and Territories.*[a]

| State or Territory. | Dry or siliceous ores. | | Copper ores. | | Lead ores. | | Zinc ores. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Alabama and Georgia | 10,097 | $3.01 | ..... | ..... | ..... | ..... | ..... | ..... |
| Alaska | 1,594,404 | 2.66 | 68,975 | $3.71 | ..... | ..... | ..... | ..... |
| Arizona | 243,900 | 9.72 | 4,274,209 | .51 | 22,039 | $21.52 | 16,106 | $2.75 |
| California | 2,296,347 | 4.57 | 494,281 | 1.79 | 2,008 | 23.08 | 4,625 | ..... |
| Colorado | 1,874,103 | 11.00 | 18,221 | 19.58 | 158,984 | 6.53 | 110,845 | .30 |
| Idaho | 122,708 | 7.85 | 40,061 | 5.47 | 1,559,724 | 2.45 | 51,050 | .35 |
| Maryland and Pennsylvania | ..... | ..... | 219,868 | .0002 | ..... | ..... | ..... | ..... |
| Michigan[b] | ..... | ..... | 2,375,000 | .111 | ..... | ..... | ..... | ..... |
| Montana | 369,241 | 8.56 | 4,332,479 | 1.32 | 11,692 | 13.28 | 225,586 | 1.23 |
| Nevada | 1,341,495 | 18.12 | 2,778,325 | .18 | 5,018 | 23.38 | 3,013 | 1.62 |
| New Mexico | 135,034 | 9.70 | 69,305 | 1.70 | 3,175 | 3.65 | 8,402 | ..... |
| North Carolina | 21,810 | 3.01 | ..... | ..... | ..... | ..... | ..... | ..... |
| Oregon | 94,353 | 5.03 | 4,205 | 3.32 | ..... | ..... | ..... | ..... |
| South Carolina | 9,302 | 2.17 | ..... | ..... | ..... | ..... | ..... | ..... |
| South Dakota | 1,945,770 | 3.87 | ..... | ..... | 357 | 30.17 | ..... | ..... |
| Tennessee[c] | ..... | ..... | 581,974 | .117 | ..... | ..... | ..... | ..... |
| Texas | 21,644 | 8.69 | ..... | ..... | 88 | 9.18 | ..... | ..... |
| Utah | 464,229 | 6.45 | 6,121,099 | .60 | 393,079 | 9.55 | 5,753 | .05 |
| Virginia and New York[c] | 1,761 | 1.29 | ..... | ..... | ..... | ..... | ..... | ..... |
| Washington | 76,239 | 12.44 | 4,362 | 4.43 | 1,653 | 2.42 | ..... | ..... |
| Wyoming | 1,447 | 8.26 | 2,044 | .23 | ..... | ..... | ..... | ..... |
| Total, 1911 | 10,623,884 | 7.50 | 21,384,408 | .67 | 2,157,817 | 4.39 | 425,380 | .89 |
| Per cent of tonnage | 29.91 | ..... | 60.20 | ..... | 6.07 | ..... | 1.20 | ..... |
| Total, 1910 | 9,646,294 | 8.07 | 19,145,677 | .74 | 2,081,545 | 4.44 | 322,008 | 1.46 |
| Per cent of tonnage, 1910 | 30.41 | ..... | 60.36 | ..... | 6.56 | ..... | 1.02 | ..... |

[a] Illinois, Missouri, the Philippines, and Porto Rico not included; crude ore tonnage, containing precious metals not known.
[b] Includes only copper ore yielding precious metals.
[c] Lead and zinc ores yielded no precious metals.

*Ore production in short tons and average extraction value of gold and silver per ton in 1911, by States and Territories*—Continued.

| State or Territory. | Copper-lead and copper-lead-zinc ores. | | Lead-zinc ores. | | Total. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| Alabama and Georgia | | | | | 10,097 |
| Alaska | | | | | 1,663,379 |
| Arizona | 129 | $23.05 | 10,756 | $5.34 | 4,567,139 |
| California | | | | | 2,797,261 |
| Colorado | 1,398 | 47.28 | 214,385 | 2.16 | 2,377,936 |
| Idaho | | | 397,354 | .70 | 2,170,897 |
| Maryland and Pennsylvania | | | | | 219,868 |
| Michigan [a] | | | | | 2,375,000 |
| Montana | 1,177 | 41.82 | 128 | | 4,940,303 |
| Nevada | 216 | 28.67 | 4,654 | 3.81 | 4,132,721 |
| New Mexico | 450 | 6.48 | 16,333 | 1.18 | 232,699 |
| North Carolina | | | | | 21,810 |
| Oregon | | | | | 98,558 |
| South Carolina | | | | | 9,302 |
| South Dakota | | | | | 1,946,127 |
| Tennessee [b] | | | | | 581,974 |
| Texas | | | | | 21,732 |
| Utah | 3,553 | 13.19 | 280,817 | 2.93 | 7,268,530 |
| Virginia and New York [b] | | | | | 1,761 |
| Washington | | | 51 | 20.29 | 82,305 |
| Wyoming | | | | | 3,491 |
| Total, 1911 | 6,923 | 25.17 | 924,478 | 1.80 | 35,522,890 |
| Per cent of tonnage | 0.02 | | 2.60 | | 100.00 |
| Total, 1910 | 20,318 | 15.11 | 502,070 | 2.67 | 31,717,912 |
| Per cent of tonnage, 1910 | 0.07 | | 1.58 | | 100.00 |

[a] Includes only copper ore yielding precious metals.
[b] Lead and zinc ores yielded no precious metals.

The total quantity of ore treated or sold in 1911 and producing gold and silver was 35,522,890 short tons, against 31,717,912 tons in 1910 and 30,564,557 tons in 1909.

The total output of dry or siliceous ores increased from 9,646,294 to 10,623,884 short tons, but decreased from 30.41 per cent of the total in 1910 to 29.91 per cent in 1911. The average precious metal value also decreased from $807 to $7.50 per ton.

The quantity of copper ores increased from 19,145,677 to 21,384,408 short tons, but the percentage of total output decreased slightly—from 60.36 per cent in 1910 to 60.20 per cent in 1911. The average precious metal value per ton decreased also, owing largely to increasing tonnages of low-grade copper ores mined, from $0.74 in 1910 to $0.67 in 1911, following a similar decrease from $0.83 in 1909 to $0.74 in 1910.

The output of argentiferous lead ores increased from 2,081,545 short tons to 2,157,817 short tons, but the ratio of these ores to total output decreased from 6.56 to 6.07 per cent and the average precious metal value per ton fell off from $4.44 in 1910 to $4.39 in 1911.

The production of gold and silver bearing zinc ores increased from 322,008 to 425,380 short tons, and the percentage of total output from 1.02 to 1.20 per cent, but the average precious metal content fell off from $1.46 to $0.89 per ton.

The output of copper-lead and copper-lead-zinc ores decreased from 20,318 to 6,923 short tons and the percentage of total output from 0.07 to 0.02 per cent, but the average precious metal value increased

from $15.11 to $25.17 per ton. The production of lead-zinc ores, however, increased from 502,070 to 924,478 short tons, and the percentage of total output from 1.58 to 2.60 per cent, while the average precious metal value decreased from $2.67 to $1.80 per ton.

The production of dry or siliceous ores increased from 1,487,260 short tons in 1910 to 1,594,404 short tons in 1911 in Alaska, from 1,963,296 to 2,296,347 tons in California, from 115,444 to 122,708 tons in Idaho, from 1,258,394 to 1,341,495 tons in Nevada, from 86,917 to 135,034 tons in New Mexico, from 82,064 to 94,353 tons in Oregon, from 1,523,868 to 1,945,770 tons in South Dakota, from 391,568 to 464,229 tons in Utah, and from 56,860 to 76,239 tons in Washington; the production decreased from 255,391 to 243,900 tons in Arizona, from 1,957,379 to 1,874,103 tons in Colorado, and from 385,067 to 369,241 tons in Montana. The great output of this class of ores is notable from Alaska, California, Colorado, Nevada, and South Dakota, and is mainly from the well-known Treadwell, Mother Lode and Grass Valley, Cripple Creek, Goldfield and Tonopah, and Homestake mines, respectively, in these States.

The output of copper ores increased from 39,365 to 68,975 short tons in Alaska, from 3,644,495 to 4,274,209 tons in Arizona, from 1,518,000 to 2, 375,000 tons in Michigan, from 2,375,490 to 2,778,325 tons in Nevada, from 55,220 to 69,305 tons in New Mexico, from 552,796 to 581,974 tons in Tennessee, and from 5,417,558 to 6,121,099 tons in Utah; and the output decreased from 716,685 to 494,281 tons in California, from 70,163 to 40,061 tons in Idaho, and from 4,517,709 to 4,332,479 tons in Montana. The large output of Utah and Nevada is largely from the disseminated deposits, that of Butte (Montana) from fissure deposits, and that of Michigan from the amygdaloid and conglomerate deposits of the Keweenaw districts.

The output of precious-metal bearing lead ores increased from 133,323 to 158,984 short tons in Colorado, and from 329,058 to 393,079 tons in Utah, but decreased from 1,566,561 to 1,559,724 tons in Idaho in 1911. The production of argentiferous lead-zinc ores increased from nothing to 397,354 short tons in Idaho in 1911, and from 231,278 to 280,817 tons in Utah, but decreased from 244,414 to 214,385 tons in Colorado; and the output of argentiferous zinc ores increased from 82,251 to 110,845 short tons in Colorado, from 34,006 to 51,050 tons in Idaho, from 169,165 to 225,586 tons in Montana.

The average extraction value per ton of precious metals derived from dry and siliceous ores decreased in Alaska from $2.77 in 1910 to $2.66 in 1911, in California from $5.23 to $4.57, in Colorado from $11.65 to $11, in Idaho from $8.57 to $7.85, in Montana from $9.19 to $8.56, in Nevada from $19.51 to $18.12, and in Washington from $15.63 to $12.44; it increased, however, from $8.65 to $9.72 in Arizona, from $9.30 to $9.70 in New Mexico, from $3.25 to $6.45 in Utah, and from $3.58 to $3.87 in South Dakota.

The average extraction value per ton of gold and silver from copper ores in Arizona was $0.51 in 1911 and $0.59 in 1910, but increased from $1.24 in 1910 to $1.32 in 1911 in Montana, and decreased from $0.117 to $0.111 in Michigan, from $0.21 to $0.18 in Nevada, and from $0.64 to $0.60 in Utah. The average value from lead ores increased from $2.27 to $2.45 in Idaho, and decreased from $12.32 to $9.55 in Utah. In lead-zinc ores the value decreased from $2.20 to $2.16 in Idaho, and from $3.33 to $2.93 in Utah.

## AVERAGE TENOR OF SILVER IN ORES, BY MINING DISTRICTS.

The bulk of the silver production, as shown, is from more widely distributed sources than that of gold, the placers and mixed ores playing little part, but the dry or siliceous silver, silver-gold, and gold-silver ores, the copper ores, and the lead ores contributing more equally in the output. In the brief summary here given detailed classification of the dry or siliceous ores is omitted.

A study of Survey data for 1911 of the mining districts shows that the average yield of the dry or siliceous ores in ounces of silver per ton was as follows: 0.013 at the Treadwell mines of Alaska, 0.056 in the Mother Lode, 0.079 at Grass Valley, and 0.962 at Campo Seco, in California; 9.050 at Leadville, 24.5 at Creede, 2.732 at Camp Bird, 2.184 at Telluride, and 0.076 at Cripple Creek, in Colorado; 0.698 in the Little Rockies, 34.101 at Butte, 12.304 at Elkhorn, and 62.010 at Flint Creek, in Montana; 29.586 at Fairview, 17.546 at Wonder, 0.324 at Goldfield, 44.914 at National, 31.660 at Seven Troughs, 0.609 at Manhattan, 26.877 at Tonopah, and 6.445 (at present) at the Virginia on the Comstock, in Nevada; 3.629 at Lordsburg, and 10.439 at the Mogollon (Cooney districts), in New Mexico; 0.350 at the Cornucopia, and 0.47 at the Cracker Creek districts, in Oregon; 0.087 at the Homestake, in South Dakota; 19.538 at Shafter, in Texas; 12.838 at Tintic, 8.611 at Bingham, 0.001 at Camp Floyd (Mercur), and 21.454 at Park City, in Utah; 4.097 at the Republic district, in Washington; and, finally, 0.028 as an average for all the dry or siliceous gold ores of the Eastern or Appalachian States. The extremely low average tenor of silver per ton of many of the districts named is due, of course, to the preponderance of gold ores, with but small quantities of silver alloyed with the gold. At the Leadville and Creede districts of Colorado, in most of the districts mentioned in Montana and Nevada, at the Mogollon in New Mexico, the Shafter in Texas, and the Tintic, Bingham, and Park City in Utah, the relatively high tenor of silver in dry or siliceous ores is noteworthy.

The average tenor of silver in fine ounces per ton in copper ores by districts in 1911 was as follows: 0.92 at the Bonanza and 18.66 at the Chitina, in Alaska; 1.49 at Warren (Bisbee), 0.33 at Globe, 0.002 at Gold Mountain (Clifton), 0.101 at the Shannon, 0.306 at the San Francisco, and 0.030 at the Ray camp, in Arizona; 2.050 at the Mammoth, in California; 21.460 at Leadville, in Colorado; 7.337 in the Coeur d'Alene, in Idaho; 0.040 in the Michigan mines; 2.209 at Butte, in Montana; 0.036 at Ely (Robinson) district, in Nevada; 0.005 at Santa Rita (Chino), and 4.249 at Lordsburg, in New Mexico; 0.22. at Ducktown, in Tennessee; 0.124 at the Cactus, 12.619 at Tintic, and 0.247 at Bingham, in Utah; 25.395 at Chewelah, in Washington; and 0.092 at the Rambler camp, in Wyoming. The relatively low silver content of the copper ores of the Clifton, Ray, and Ely districts, and especially of the Santa Rita district, is notable, as are the relatively high tenors of silver in the Chitina region, and in the Leadville, Tintic, and Chewelah districts.

The average silver content in fine ounces per ton in 1911 in lead ores was as follows: 25.47 at Tombstone, in Arizona; 32.20 at Keeler, in California; 7.61 at Leadville and 15.60 at Aspen, in Colorado; 13.98 at Gilmore, and 2.22 at Hunter, 6.61 at Lelande, and 3.04 at Yreka (the last three named being in the Coeur d'Alene), in Idaho; 12.65 at Butte and 70.00 at Flint Creek, in Montana; 9.77 at Yellowpine and

12.83 at Ely, in Nevada; 3.04 at Magdalena, in New Mexico; 17.32 at Shafter, in Texas; and 11.93 at Frisco, 21.01 at Tintic, 7.38 at Bingham, 10.18 at Rush Valley, and 20.32 at Park City, in Utah. The general high average content of silver in lead ores is characteristic, the notable exceptions being in the Cœur d'Alene.

## DISTRIBUTION OF GOLD PRODUCTION OF 1911, BY SOURCES.

As shown in the following tables, the great bulk of the gold output is from dry or siliceous ores—normally gold-quartz ores—and placers. In a later report it is hoped some detailed data may be presented showing variations in gold content of placer gravels and of gold-quartz ores in the different mining districts of the United States and Alaska.

Nearly 93 per cent of the total gold production of the United States is from the combined contributions of the placers and the deep mines producing dry or siliceous ores. The output of gold derived from the great copper and lead mines of the United States is therefore relatively small. The relative proportion of output by sources showed little change in 1911 from 1910. It is interesting to note, however, that 24.17 per cent of the gold production came from placers in 1911, against 23.76 per cent in 1910, and that 68.52 per cent came from dry or siliceous ores, against 68.91 per cent in 1910. Normally changes would be expected in opposite directions. There was decreased relative output from copper ores, also, and increased relative production from lead ores.

The following table shows the sources by classes of ore by States of the gold output in 1911, and for comparison the corresponding total figures for the United States for 1910:

*Source of gold in 1911 in States and Territories, as reported from the mines to the United States Geological Survey, by kinds of ore and by States, in fine ounces.*[a]

| State or Territory. | Placers. | Dry or siliceous ores. | Copper ores. | Lead ores. |
|---|---|---|---|---|
| Alabama | | 915.06 | | |
| Alaska | 606,622.50 | 204,465.99 | 4,187.77 | |
| Arizona | 1,143.63 | 104,011.72 | 51,377.93 | 6,651.95 |
| California | 434,723.24 | 499,123.29 | 20,694.28 | 328.86 |
| Colorado | 15,468.34 | 866,252.76 | 8,472.08 | 17,765.42 |
| Georgia | 1,148.32 | 548.19 | | |
| Idaho | 19,559.32 | 38,040.41 | 4,492.30 | 3,843.44 |
| Maryland and Pennsylvania | | | .44 | |
| Montana | 33,127.25 | 111,487.49 | 31,300.27 | 2,717.90 |
| Nevada | 10,181.05 | 847,124.81 | 21,841.27 | 895.66 |
| New Mexico | 905.29 | 33,035.23 | 2,920.69 | 8.04 |
| North Carolina | 247.24 | 3,152.65 | | |
| Oregon | 8,140.25 | 22,080.33 | 420.48 | |
| South Carolina | 12.63 | 974.61 | | |
| South Dakota | 584.03 | 359,114.47 | | 205.40 |
| Tennessee | | | 562.17 | |
| Texas | | 1.02 | | |
| Utah | 272.54 | 78,912.69 | 117,247.94 | 25,709.04 |
| Virginia | 39.09 | 109.13 | | |
| Washington | 193.45 | 40,684.39 | 117.53 | 2.00 |
| Wyoming | 340.61 | 575.76 | 12.43 | |
| Total | 1,132,708.78 | 3,210,610.00 | 263,647.58 | 58,127.71 |
| Value | $23,415,168 | $66,369,199 | $5,450,079 | $1,201,606 |
| Per cent of total | 24.17 | 68.52 | 5.63 | 1.25 |
| Total, 1910 | 1,089,206.15 | 3,159,520.84 | 264,669.29 | 54,281.10 |
| Value | $22,515,889 | $65,313,092 | $5,471,200 | $1,122,090 |
| Per cent of total | 23.76 | 68.91 | 5.77 | 1.18 |

[a] Philippines and Porto Rico not included.

*Source of gold in 1911 in States and Territories, as reported from the mines to the United States Geological Survey, by kinds of ore and by States, in fine ounces*—Continued.

| State or Territory. | Zinc ores. | Copper-lead and copper-lead-zinc ores. | Lead-zinc ores. | Total. |
|---|---|---|---|---|
| Alabama | | | | 915.06 |
| Alaska | | | | 815,276.26 |
| Arizona | 1,119.01 | 13.01 | 1,633.33 | 165,950.58 |
| California | | | | 954,869.67 |
| Colorado | 164.54 | 882.05 | 10,215.35 | 919,220.54 |
| Georgia | | | | 1,696.51 |
| Idaho | 7.74 | | 446.01 | 66,389.22 |
| Maryland and Pennsylvania | | | | .44 |
| Montana | 817.15 | 48.81 | | 179,498.87 |
| Nevada | .29 | 47.60 | 14.90 | 880,105.58 |
| New Mexico | | 17.59 | 14.00 | 36,900.84 |
| North Carolina | | | | 3,399.89 |
| Oregon | | | | 30,641.06 |
| South Carolina | | | | 987.24 |
| South Dakota | | | | 359,903.90 |
| Tennessee | | | | 562.17 |
| Texas | | | | 1.02 |
| Utah | 1.60 | 114.16 | 4,959.31 | 227,217.28 |
| Virginia | | | | 148.22 |
| Washington | | | 9.00 | 41,006.37 |
| Wyoming | | | | 928.80 |
| Total | 2,110.33 | 1,123.22 | 17,291.90 | 4,685,619.52 |
| Value | $43,624 | $23,221 | $357,455 | $96,860,352 |
| Per cent of total | 0.04 | 0.02 | 0.37 | 100.00 |
| Total, 1910 | 2,952.61 | 846.55 | 13,426.04 | 4,584,902.58 |
| Value | $61,036 | $17,500 | $277,541 | $94,778,348 |
| Per cent of total | 0.07 | 0.02 | 0.29 | 100.00 |

## RECOVERIES BY METHODS OF TREATMENT.

In another table data are given showing relative recoveries of deep mine gold by methods of treatment in mills and by smelting. For 1911 the placers, whose product is largely mechanical, although in part by amalgamation, produced 24.2 per cent of the total gold, as shown above; the gold mills produced (all from siliceous ores) 54.2 per cent of the total output—23.9 per cent by amalgamation, 26.5 per cent by cyanidation, and 3.8 per cent by chlorination; and the smelters produced the remaining 22 per cent—14.7 per cent from dry or siliceous ores and 7.3 per cent from all other ores combined. These figures can not be compared with those for previous years, for detailed data of this kind were obtained for the first time, so far as known, for 1911. It will probably be found from future comparisons that relative recoveries from placers and by chlorination will in general decrease.

### PLACERS.

The total value of the gold placer production was $23,415,168 in 1911, against $22,515,889 in 1910. These figures represent 24.17 per cent of the total domestic gold output for 1911 and 23.76 per cent of that for 1910. The placer production of Alaska was $12,540,000 against $11,984,806 in 1910, and that of California was $8,986,527 against $8,888,795 in 1910.

Dredging supplied $10,311,589 in 1911, against $9,293,106 in 1910. Of this California alone produced $7,666,461 in 1911, against $7,550,254 in 1910. The total production of gold by dredging in California to the end of 1911 was $47,985,236. In 1911 Alaska produced by dredging $1,500,000, against $800,000 in 1910. The gold output by dredges and the number of boats in 1911 and 1910 for the United States is shown in the following table:

*Gold output in the United States in 1910 and 1911, in dollars, and number of dredges producing, by States.*

| | 1910 | | 1911 | |
|---|---|---|---|---|
| | Output. | Number dredges. | Output. | Number dredges. |
| Alaska | $800,000 | 18 | $1,500,000 | 27 |
| California | 7,550,254 | 72 | 7,666,461 | 65 |
| Colorado | 344,210 | 6 | 272,173 | 4 |
| Idaho | 91,247 | 6 | 243,965 | 7 |
| Montana | 473,385 | 5 | 597,824 | 9 |
| Oregon | 34,010 | 6 | 14,575 | 3 |
| Other States [a] | | | 16,591 | 5 |
| Total | 9,293,106 | 113 | 10,311,589 | 120 |

[a] Nevada, 2 dredges; South Dakota, Georgia, North Carolina, 1 dredge each.

The remainder of the placer production was chiefly from drift mining (which is especially important in Alaska in frozen ground at no great depth, and in California in ancient buried river channels,[1] often at considerable depth), and from hydraulic and sluicing placers. In California, especially, hydraulic mining has been of much importance in the past and a special branch of the industry in itself, but restrictive laws relative to the débris and to disturbance of navigable streams have in recent years greatly confined mining activity of this kind. There is also a small annual output of placer gold from hand washing, and from the operation of so-called "dry-washing" machines in the arid regions of the Southwest. A larger production is probably now being made from this last-named source in northwestern Mexico and Lower California. Figures for domestic production from "dry washing" are not yet available, but the output has been small to date.

### DRY PLACERS.

In parts of the arid regions of the Southwest, notably Arizona, southern California, and adjoining areas in northern Mexico gold has long been known to occur in variable quantities, to some extent in veins but to much greater extent in weather-worn, concentrated form in dry, loose gravels near the surface and in lime-cemented gravel (*caliche, argo masa*) below. Natural concentration of the gold liberated by breaking down of vein croppings has been effected by the small annual rainfall of the country gathering temporarily in depressed areas and channels and leaving the heavier material in these depressions after it disappears. This rainfall, however, is of

[1] Lindgren, Waldemar, The Tertiary gravels of the Sierra Nevada of California: Prof. Paper U. S. Geol. Survey No. 73, 1911.

insufficient quantity to be depended upon to assist in present economical extraction by hydraulic methods used elsewhere in recovery of placer gold. In earlier years the Sonora district in Mexico undoubtedly produced much gold from the loose surface gravels, mainly by simple pneumatic concentration in bateas and Hungarian "dry washers," operated by hand.

It seems probable that further production of gold can be expected from some of these dry placers, but whether at a profit to operators and investors or not will depend upon thorough understanding of the conditions, and technical and financial management not only honest but efficient and economical as well. Costly and financially unprofitable experiments have been reported in attempts at recovery of gold by "dry washing" of some of these deposits, and intending investors might profitably consult the literature already available on the subject. Detailed information relative to the geology and occurrence of this dry-gravel gold in the southwestern United States is still largely lacking.

Recent Survey publications giving some information on dry placer gold in the Southwest are papers by Hill,[1] Hess,[2] and Lindgren, Graton, and Gordon,[3] and the chapters on New Mexico, Arizona, Utah, and California in the annual reports of the Survey, "Gold, silver, copper, lead, and zinc in the Western States (mine production)," published as advance chapters and also in the volumes "Mineral resources of the United States." All of these papers can be had free on application to the Director, United States Geological Survey, Washington, D. C., until the Survey stock is exhausted, and after that on payment of cost of publication to the Superintendent of Documents, Washington, D. C. As the recovery of gold from dry gravels has been the subject of many inquiries to the Survey the following list of recent references to the literature is given. Copies of these papers can in most cases probably be had at small cost from publishers of the leading mining journals.

Baker, H. D., Placer gold machine: Min. Sci., vol. 64, 1911, p. 538.

Carey, E. E., Working dry placers: Am. Metall. Soc., vol. 1, 1911, p. 6.

Dolbear, S. H., Dry placer mining in California: Eng. and Min. Jour., vol. 89, 1910, p. 359. Describes dry placer gravels in Summit region, San Bernardino County, Cal., and experiments of Jardine and Patton in recovery of gold.

Engineering and Mining Journal, Dry pulverizer and separator, vol. 89, 1910, p. 858. Describes Quinner dry pulverizer and separator.

——— Special correspondence. The Altar gold placer fields of Sonora, Mexico, vol. 90, 1910, pp. 651–653. Gives history of operations in dry placer mining, brief descriptions of deposits, and working of Quinner dry pulverizer.

——— Editorial correspondence, vol. 91, 1911, p. 535. Gives notes on probable working of dry gravels in the Summit region, north of Randsburg, San Bernardino County, Cal.

Ficket, F. W., Dry placer mining in Quijotoa district (Arizona-Mexico): Min. and Sci. Press, vol. 102, 1911, p. 291. Describes occurrence of gold in *caliche* or lime-cemented conglomerate, and operations of Quinner and Stebbins machines.

Jardine, J. B., jr., Dry concentration of placer gold: Am. Metall. Soc., vol. 1, 1911, p. 21.

Merrill, F. J. H., Dry placers of northern Sonora, Mexico: Min. and Sci. Press, vol. 97, 1908, pp. 360–361. Describes dry gold gravels of Altar region, Sonora, Mexico, and Hungarian "dry washer" machine, and briefly states essentials for successful working of gravels.

[1] Hill, J. M., Notes on placer deposits of Greaterville, Ariz.: Bull. U. S. Geol. Survey No. 430, 1910, pp. 11–22.

[2] Hess, F. L., Gold mining in the Randsburg quadrangle, Cal.: Bull. U. S. Geol. Survey No. 430, 1910, pp. 23–47.

[3] Lindgren, Waldemar, Graton, L. C., and Gordon, C. H., The ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, pp. 74–76.

Merrill, F. J. H., Dry concentration of placer gold: Min. and Sci. Press, vol. 105, 1912, pp. 50–52. Latest and most complete summary of subject.

Mining Magazine. Précis of technology; dry concentration of placer gold, vol. 7, 1912, pp. 148–149. Résumé of article by same title of F. J. H. Merrill cited above.

Peterson, G. M., Dry placer machines: Min. and Sci. Press, vol. 191, 1910, p. 639. Describes Quinner pulverizer and Stebbins concentrator.

Richards, J. V., Dry washing for placer gold in Sonora, Mexico: Trans. Am. Inst. Min. Eng., vol. 41, 1911, pp. 797–802. Describes operations of "dry washing" machines and Quinner pulverizer.

Wilson, E. B., Dry placer mining machines: Mines and Minerals, vol. 31, 1911, p. 589.

### DRY AND SILICEOUS ORES.

In 1911 dry and siliceous ores, including true gold ores and precious metal bearing ores not classed as copper, lead, or zinc ores, produced $66,369,199 in gold, against an output from this source of $65,313,092 in 1910. States producing over $1,000,000 from these ores in 1911 ranked as follows: Colorado, Nevada, California, South Dakota, Alaska, Montana, Arizona, and Utah, or in the same relative order as in 1910 and 1909.

Considerably increased output from this source was recorded for 1911 from South Dakota and Utah, and decreases are found from Colorado and Nevada.

The siliceous ores are in part free-milling (amalgamating), as in Alaska, California, and Oregon; in part both amalgamating and concentrating, as in many States; in smaller part simply concentrating ores, as in parts of Colorado and Arizona; or smelting ores. Tailings both from old dumps and from present milling are largely reworked by concentration and subsequent cyanidation. The all-sliming cyanidation method is also of increasing importance, and crushing is now largely by tube mills as well as by stamp and gyratory mills.

The loss in tailings from gold mills is being constantly cut down and the most serious present loss is in tailings from concentrating plants. The chlorination process is of decreasing relative importance. Smelting is mainly of concentrates and of siliceous and pyritic ores which are also valuable as fluxes. Exact figures of relative output by methods have already been briefly given and will appear in detail by States in another table.

### COPPER ORES.

The production of gold from copper ores in 1911 was $5,450,079, against $5,471,200 from this source in 1910. Increases in gold output from these ores are noted for 1911 from Alaska, Idaho, Nevada, New Mexico, and Utah, and decreases from most of the other copper-producing States, notably California. The States leading in output of gold from these ores are Utah (predominantly) and Arizona (each with an output of over $1,000,000 from this source), and Montana, Nevada, and California, all in the order named. The gold is recovered by electrolytic refining of blister copper obtained in smelting crude ores and concentrates.

### LEAD ORES.

The output of gold from lead ores in 1911 was $1,201,606, against a production from this source of $1,122,090 in 1910. The Utah lead ores rank first in total yield of gold, followed by those from Colorado. The remainder of gold from this source is chiefly from Arizona, Idaho, and Montana, in the order named. Increases in 1911 are noted from Arizona, Colorado, and Idaho, and decreases from most of the other States.

LEAD-ZINC, ZINC, AND MIXED ORES.

Production of gold from lead-zinc ores was $357,455 in 1911, against $277,541 in 1910, and was mainly from Colorado, Utah, and Arizona, in the order named. In Colorado and Arizona there were increases and in Utah there was a small decrease in 1911.

From zinc ores $43,624 in gold was produced in 1911, against $61,036 in 1910, mainly from Arizona, Montana, and Colorado, in the order named. The output from Montana alone increased in 1911.

Mixed copper-lead and copper-lead-zinc ores yielded $23,221 in gold in 1911, against $17,500 in 1910, the production being chiefly from Colorado and Utah.

## DISTRIBUTION OF SILVER PRODUCTION OF 1911, BY SOURCES.

The mine production of silver from dry or siliceous ores, copper ores, and lead ores combined in 1911 was 94.21 per cent of the total output, against 94.06 per cent in 1910 and 92.24 per cent in 1909. The production from dry or siliceous ores increased from 40.15 per cent of the total in 1910 to 41.25 per cent in 1911, but the output from copper ores decreased from 27.82 to 27.43 per cent, and that from lead ores decreased from 26.09 to 25.53 per cent. The production from lead-zinc ores increased. All of these changes are in the same direction as those noted in 1910. The small output from refining placer gold remained the same as in 1910, at 0.28 per cent of the total production, and the small outputs from zinc and mixed ores both decreased.

The following table shows the source of silver production of the United States in 1911 by classes of ores by States:

*Source of silver in 1911 in States and Territories, as reported from the mines to the United States Geological Survey, by kinds of ore and by States, in fine ounces.*[a]

| State or Territory. | Placers. | Dry or siliceous ores. | Copper ores. | Lead ores. |
|---|---|---|---|---|
| Alabama | | 171 | | |
| Alaska | 110,288 | 29,829 | 320,114 | |
| Arizona | 154 | 414,981 | 2,136,121 | 635,363 |
| California | 39,541 | 291,896 | 864,397 | 74,611 |
| Colorado | 3,669 | 5,096,026 | 342,550 | 1,265,594 |
| Georgia | 109 | 103 | | |
| Idaho | 4,851 | 332,864 | 254,095 | 7,059,990 |
| Illinois | | | | 3,036 |
| Maryland and Pennsylvania | | | 87 | |
| Michigan | | | 497,281 | |
| Missouri | | | | 49,867 |
| Montana | 5,123 | 1,613,253 | 9,597,752 | 186,926 |
| Nevada | 4,536 | 12,830,194 | 111,474 | 186,485 |
| New Mexico | 162 | 1,183,265 | 108,892 | 21,537 |
| North Carolina | 22 | 921 | | |
| Oregon | 1,257 | 34,011 | 9,953 | |
| South Carolina | | 11 | | |
| South Dakota | 68 | 183,317 | | 20,370 |
| Tennessee | | | 106,660 | |
| Texas | | 422,870 | | 1,524 |
| Utah | 33 | 2,569,157 | 2,377,946 | 6,083,877 |
| Virginia | 7 | 14 | | |
| Washington | 54 | 202,768 | 31,899 | 7,458 |
| Wyoming | 210 | 98 | 417 | |
| Total, 1911 | 170,084 | 25,205,749 | 16,759,638 | 15,596,638 |
| Value | $90,144 | $13,359,047 | $8,882,608 | $8,266,218 |
| Per cent of total | 0.28 | 41.25 | 27.43 | 25.53 |
| Total, 1910 | 159,381 | 23,125,042 | 16,024,543 | 15,028,076 |
| Value | $86,066 | $12,487,523 | $8,653,253 | $8,115,161 |
| Per cent of total | 0.28 | 40.15 | 27.82 | 26.09 |

[a] Philippines and Porto Rico not included in this table.

*Source of silver in 1911 in States and Territories, as reported from the mines to the United States Geological Survey by kinds of ore and by States, in fine ounces*—Continued.

| State or Territory. | Zinc ores. | Copper-lead and copper-lead-zinc ores. | Lead-zinc ores. | Total. |
|---|---|---|---|---|
| Alabama | | | | 171 |
| Alaska | | | | 460,231 |
| Arizona | 40,067 | 5,102 | 44,783 | 3,276,571 |
| California | | | | 1,270,445 |
| Colorado | 55,969 | 90,311 | 476,049 | 7,330,168 |
| Georgia | | | | 212 |
| Idaho | 33,669 | | 510,667 | 8,196,136 |
| Illinois | | | | 3,036 |
| Maryland and Pennsylvania | | | | 87 |
| Michigan | | | | 497,281 |
| Missouri | | | | 49,867 |
| Montana | 491,161 | 90,981 | | 11,985,196 |
| Nevada | 9,216 | 9,826 | 32,870 | 13,184,601 |
| New Mexico | | 4,814 | 35,870 | 1,354,540 |
| North Carolina | | | | 943 |
| Oregon | | | | 45,221 |
| South Carolina | | | | 11 |
| South Dakota | | | | 203,755 |
| Tennessee | | | | 106,660 |
| Texas | | | | 424,394 |
| Utah | 491 | 83,972 | 1,358,311 | 12,473,787 |
| Virginia | | | | 21 |
| Washington | | | 1,602 | 243,781 |
| Wyoming | | | | 725 |
| Total, 1911 | 630,573 | 285,006 | 2,460,152 | 61,107,840 |
| Value | $333,604 | $151,053 | $1,303,881 | $32,387,155 |
| Per cent of total | 1.03 | 0.47 | 4.01 | 100.00 |
| Total, 1910 | 755,369 | 535,987 | 1,968,311 | 57,596,709 |
| Value | $407,899 | $289,433 | $1,062,888 | $31,102,223 |
| Per cent of total | 1.31 | 0.93 | 3.42 | 100.00 |

## RECOVERIES BY METHODS OF TREATMENT.

Placers yielded 0.3 per cent of the total silver output in 1911. In gold and silver mills 15.67 per cent was recovered—1.54 per cent by amalgamation and 14.13 per cent by cyanidation. The remainder of the silver production, 84.03 per cent of the total, was recovered by smelting—25.31 per cent coming from dry or siliceous ores, 27.43 per cent from copper ores, 25.53 per cent from lead ores, 1.03 per cent from zinc ores, 0.47 per cent from mixed ores, and 4.01 per cent from lead-zinc ores. The smelting of the three great classes of ores therefore produced, in nearly equal quantities from each, 78.27 per cent of the total silver output; milling yielded 15.94 per cent, and the placers and smelting of the other ores the small remainder.

## PLACERS.

The output of silver from placers, mainly in Alaska and California, was 170,084 fine ounces in 1911, against 159,381 fine ounces in 1910. The recovery is by refining the placer gold.

### DRY AND SILICEOUS ORES.

The output of silver from dry and siliceous ores was 25,205,749 fine ounces in 1911, against 23,125,042 fine ounces in 1910. The most notable gains were in Utah, from 548,498 ounces in 1910 to 2,569,157 ounces in 1911, and in Nevada, from 11,763,012 ounces in 1910 to 12,830,194 ounces in 1911. Other increases in output of silver from this source were in California, from 257.355 to 291,896 ounces; in New Mexico, from 708,762 to 1,183,265 ounces; in South Dakota, from 117,333 to 183,317 ounces; in Texas, from 379,402 to 422,870 ounces; and in Washington, from 194,078 to 202,768 ounces. Decreased production was notable in Colorado, from 6,117,719 ounces in 1910 to 5,096,026 ounces in 1911; and in Montana, from 2,139,405 to 1,613,253 ounces.

In order of production from this source the first five States ranked as follows in 1911: Nevada, Colorado, Utah, Montana, and New Mexico.

With a few notable exceptions, where there are mines producing true silver ores, as in San Bernardino County, Cal., the dry or siliceous ores are gold-silver or silver-gold ores (the latter notable at Tonopah, Nev.). The rich surface outcrops, mainly of chloride silver ores, found and worked in the arid West in the early days, have long since been exhausted in explored territory, and there appears little likelihood of further extensive supply from new finds. Deeper silver deposits may of course at any time be found. With high prices of silver, old silver producers closed down 20 years ago in the West may be reopened and prove productive again.

The Nevada output is mainly from the Tonopah district, and the Colorado production is chiefly from the Leadville, Upper San Miguel, and Sneffels districts. As shown already, a large part of the output of silver from the gold-silver siliceous ores is with the gold by amalgamation and cyanidation and the metals are separated in refining the gold. The remainder is produced by smelting the richer ores, and the silver is then recovered in the refining of the copper or lead bullion.

### COPPER ORES.

The production of silver from copper ores was 16,759,638 fine ounces in 1911, against 16,024,543 ounces in 1910, corresponding to an increased copper output in 1911. The silver production from copper ores is from electrolytic refining of Lake and blister copper produced by smelting. The copper ores are mainly sulphides (except the Lake ores of Michigan, which are native metal in amygdaloid or conglomerate matrix), and a greater tonnage contains chalcocite, chiefly secondary, than primary chalcopyrite, or cupriferous pyrite. The great disseminated copper deposits of Utah, Arizona, Nevada, and New Mexico are of constantly increasing importance. The silver content per ton of the extensive Chino deposits of Santa Rita, in New Mexico, however, are notably low in silver, as is shown in another table. Copper ores are mainly concentrated before smelting. Oxidized copper ores of decreasing relative importance, which are sought for largely as fluxing ores and commonly smelted crude, still come from the Bisbee and Tintic districts.

In output of silver from copper ores Montana led with 9,597,752 fine ounces in 1911, against 9,153,590 ounces in 1910; Utah followed

with 2,377,946 fine ounces, against 2,036,909 ounces in 1910; Arizona produced 2,136,121 ounces, against 1,934,363 ounces in 1910; and California ranked fifth with 864,397 ounces in 1911, against 1,363,668 ounces in 1910. The output of silver from copper ores in Colorado and Idaho has greatly fallen off in the last two years, but that from Nevada has increased. The production from Montana is mainly from Butte, that of Utah from Tintic and Bingham, that of California from Shasta County, and that of Arizona mainly from Bisbee and Jerome. Of these districts Bingham alone represents the disseminated type of deposit, and the silver output from these copper ores is still chiefly from deep lodes.

### LEAD ORES.

The silver production from argentiferous lead ores in 1911 was 15,596,638 fine ounces, against 15,028,076 ounces in 1910. The output from Idaho has increased from 5,692,906 ounces in 1909 to 6,479,636 ounces in 1910 and to 7,059,990 ounces in 1911. The output of Utah has decreased from 8,314,766 ounces in 1909 to 6,423,523 ounces in 1910 and to 6,083,877 ounces in 1911. The production in Colorado increased in 1911, but that from Nevada fell off. The output in Idaho is mainly from the Cœur d'Alene, that in Utah from the Park City and Tintic districts, and that in Colorado from Aspen and Leadville. Although much of this silver production is from argentiferous galena, oxidized silver-lead ores are still mined at Tintic, Aspen, and a few other camps.

### ZINC, LEAD-ZINC, AND MIXED ORES.

Argentiferous zinc ores supplied 630,573 fine ounces of silver in 1911, against 755,369 ounces in 1910, the output and the decrease for 1911 being mainly from the Butte district of Montana, where the zinc-mining industry has been making rapid strides.

Lead-zinc ores furnished 2,460,152 fine ounces of silver in 1911, against 1,968,311 ounces in 1910. Production from this source increased from 1,228,398 ounces to 1,358,311 ounces in Utah, and from no recorded output for 1910 to 510,667 ounces in 1911 in Idaho; but it decreased from 679,500 ounces to 476,049 ounces in Colorado.

Copper-lead and copper-lead-zinc ores in 1911 yielded 285,006 fine ounces of silver, against 535,987 ounces in 1910. The production is mainly from Montana, Colorado, and Utah, in nearly equal quantities. The output from Montana increased, but decreases were large in Colorado and Utah.

## DISTRIBUTION OF PRODUCTION OF GOLD AND SILVER, BY METHODS OF TREATMENT.

In the Survey report on gold and silver for 1910 figures were first published showing the distribution of output by methods of treatment.

In the following table a summary is given of the distribution of the gold and silver production of the United States in 1911, showing—

1. Total crude ore, tailings, and slags sold or treated in 1911.
2. Crude ore treated in gold and silver mills.
3. Crude ore concentrated, with resulting concentrates.
4. Crude ore shipped to smelters.
5. Old tailings and slags treated.

The last four include recoverable gold and silver content in fine ounces.

*Distribution of production of gold and silver in 1911, by methods of treatment, by States.*

| State or Territory. | Total quantity of ore, tailings, and slag treated or sold in 1911. | Ore to gold and silver mills. | | | Ore to concentrating mills. | Concentrates produced. | | |
|---|---|---|---|---|---|---|---|---|
| | | Quantity. | Gold in bullion. | Silver in bullion. | Quantity. | Quantity. | Gold. | Silver. |
| | *Short tons.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Short tons.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* |
| Alaska | 1,663,379 | 1,594,404 | 120,201 | 19,171 | ..... | 29,060 | 84,265 | 10,658 |
| Arizona | 4,567,139 | 169,723 | 92,623 | 49,162 | 2,624,037 | 314,761 | 10,940 | 388,173 |
| California | 2,797,261 | 2,156,950 | 380,632 | 141,747 | ..... | 49,157 | 99,311 | 35,466 |
| Colorado | 2,377,936 | 1,373,879 | 604,937 | 404,878 | 465,283 | 201,010 | 109,817 | 1,967,545 |
| Idaho | 2,170,897 | 114,461 | 35,226 | 280,072 | 1,820,719 | 222,748 | 4,723 | 5,221,406 |
| Montana | 4,940,303 | 249,120 | 55,747 | 122,823 | 4,038,729 | 1,320,679 | 29,029 | 7,751,426 |
| Nevada | 4,132,721 | 1,222,585 | 729,252 | 7,165,892 | 2,751,552 | 269,709 | 81,098 | 2,581,229 |
| New Mexico | 232,699 | 109,113 | 21,894 | 771,014 | 59,622 | 16,243 | 7,939 | 333,654 |
| Oregon | 98,558 | 49,478 | 7,862 | 2,528 | ..... | 1,493 | 7,117 | 20,438 |
| South Dakota | 1,946,127 | 1,940,661 | 354,005 | 172,598 | ..... | 41 | 68 | 8 |
| Texas | 21,732 | 21,644 | ..... | 418,166 | ..... | 96 | 1 | 4,704 |
| Utah | 7,268,530 | 267,111 | 30,312 | 112,493 | 5,840,091 | 357,370 | 50,225 | 2,478,012 |
| Washington | 82,305 | 11,846 | 2,162 | 697 | 108 | 36 | 1 | 1,467 |
| Wyoming | 3,491 | 1,447 | 576 | 98 | 1,674 | 99 | 10 | 154 |
| Eastern or Appalachian States | 625,444 | 42,668 | 4,910 | 1,206 | 500 | 368 | 427 | 101 |
| Total | 32,928,522 | 9,325,090 | 2,440,339 | 9,662,545 | 17,602,315 | 2,773,870 | 484,971 | 20,794,441 |
| Total, 1910 | 30,287,175 | 8,528,596 | 2,366,322 | 8,245,851 | 15,407,517 | 2,597,992 | 475,452 | 19,949,379 |

| State or Territory. | Crude ore to smelter. | | | Old tailings and slags treated. | | |
|---|---|---|---|---|---|---|
| | Quantity. | Gold. | Silver. | Quantity. | Gold. | Silver. |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* |
| Alaska | 68,975 | 4,188 | 320,114 | ..... | ..... | ..... |
| Arizona | 1,727,451 | 60,689 | 2,819,873 | 45,928 | 555 | 19,209 |
| California | 538,214 | 31,033 | 1,004,472 | 102,097 | 9,171 | 49,219 |
| Colorado | 538,774 | 188,998 | 4,954,076 | ..... | ..... | ..... |
| Idaho | 136,932 | 6,881 | 2,689,807 | 98,785 | ..... | ..... |
| Montana | 645,903 | 61,568 | 4,105,092 | 6,551 | 28 | 732 |
| Nevada | 109,119 | 59,570 | 3,432,407 | 49,465 | 5 | 537 |
| New Mexico | 63,964 | 6,163 | 249,710 | ..... | ..... | ..... |
| Oregon | 4,834 | 4,042 | 17,009 | 44,246 | 3,480 | 3,989 |
| South Dakota | 5,466 | 5,247 | 31,081 | ..... | ..... | ..... |
| Texas | 88 | ..... | 1,524 | ..... | ..... | ..... |
| Utah | 1,103,054 | 144,889 | 9,859,665 | 58,274 | 1,519 | 23,584 |
| Washington | 63,353 | 37,328 | 239,358 | 6,998 | 1,322 | 2,205 |
| Wyoming | 370 | 2 | 263 | ..... | ..... | ..... |
| Eastern or Appalachian States | 582,274 | 746 | 106,660 | 2 | 179 | ..... |
| Total | 5,588,771 | 611,344 | 29,831,111 | 412,346 | 16,259 | 99,475 |
| Total 1910 | 6,016,425 | 623,272 | 28,487,837 | 334,637 | 30,323 | 333,809 |

The first item consists of all classes of ores, tailings, and slag producing gold and silver in the United States in 1911. The grand total shows that this tonnage increased from 30,287,175 short tons in 1910 to 32,928,522 short tons in 1911. This takes no account of placer gravel, but represents product of deep mines only. The largest increase in quantity in 1911 was in Utah, followed by considerable increases in Arizona, South Dakota, and Nevada. The quantity decreased in Colorado and Montana.

In reference to the second item, many gold and silver mills employ concentrating apparatus, and the concentrates resulting are combined with those from straight concentrating mills in the column of the table "Concentrates produced." The gold and silver recovery under this item is mainly by amalgamation and cyanidation, as shown in detail in the last table of this report. The total quantity of crude

ore treated in gold and silver mills of the United States increased from 8,528,596 short tons in 1910 to 9,325,090 short tons in 1911. Increases in tonnage milled are noted particularly for Alaska, California, Nevada, New Mexico, and South Dakota, and considerable decreases for Colorado. The total quantity of gold recovered by mills in 1911 was 2,440,339 fine ounces, against 2,366,322 ounces in 1910, with increased output from Arizona, Nevada, New Mexico, and South Dakota (notably), and decreases in most of the other States. The total silver recovery in mills was 9,662,545 fine ounces in 1911, against 8,245,851 ounces in 1910. There was considerably increased production of silver from mills in Colorado, Montana, Nevada (notably), New Mexico, South Dakota, Texas, and Utah in 1911.

Under the third item is given the quantity of ore treated for concentration only, including the large quantities of copper, lead, zinc, and mixed ores, whose concentrates are smelted primarily for these metals, the gold and silver being recovered in refining the copper, lead, and zinc. Examples are the copper ores of the disseminated deposits of Bingham, Utah, the ores of Butte, Mont., the lead ores of the Coeur d'Alene, Idaho, and some of the lead-zinc and mixed ores of Leadville, Colo. The quantity of concentrates produced and the recoverable gold and silver content, however, as already stated, represent not only the concentrates from these straight concentrating mills but also those from gold and silver mills. The concentrates are mainly smelted, as stated, but are in some cases treated in gold and silver mills by the processes named. Comparison with corresponding figures published by the Survey for 1910 show that the total tonnage treated in straight concentrating mills increased from 15,407,517 short tons in 1910 to 17,602,315 tons in 1911, the greater part of the increase being credited to Arizona, Idaho, Nevada, and Utah. The total gold and silver bearing concentrates produced in all classes of mills increased in quantity from 2,597,992 short tons in 1910 to 2,773,870 tons in 1911, the increases being mainly in Arizona, Idaho, Montana, Nevada, and Utah. The total recoverable gold content of the concentrates increased from 475,452 fine ounces in 1910 to 484,971 ounces in 1911, the increases being chiefly in Alaska, Arizona, California, Nevada, New Mexico, and Utah, and the decreases mainly in Colorado and Montana. The silver in concentrates produced increased from 19,949,379 fine ounces in 1910 to 20,794,441 ounces in 1911, the increases being most notable in Arizona, Idaho, New Mexico, Oregon, and Utah, and the decreases in Colorado and Montana.

The fourth item covers quantity and recoverable precious-metal content of crude ore shipped direct to smelters from the mines, and in general includes the richer gold, silver, copper, lead, and zinc ores from which the gold and silver are eventually recovered by refining the copper or lead bullion that collects the precious metals in the smelting. The total quantity shipped of this class of ore decreased from 6,016,425 short tons in 1910 to 5,588,771 tons in 1911, the decreases being mainly in Arizona and California, and increases being recorded for most of the other States. The tonnages are notably large for Arizona and Utah, and the bulk of the precious-metal producing ores of the Eastern States are smelted crude. The total gold output from crude smelting ores decreased from 623,272 fine ounces in 1910 to 611,344 ounces in 1911, the decreases being chiefly in California, Colorado, Nevada, and South Dakota, and increases being

recorded for most of the other States, notably Utah. The total silver production from crude smelting ore increased from 28,487,837 fine ounces in 1910 to 29,831,111 ounces in 1911. The production of silver from this class of ore increased notably in Alaska, Arizona, Idaho, Montana, Nevada, New Mexico, and Utah, and fell off considerably in Colorado.

Under the fifth item is given the quantity of old material, principally slags and tailings, re-treated and their recoverable contents. These are largely smelted, sometimes mainly for their fluxing values, but increasing quantities of old tailings are now concentrated and cyanided, as in the case of Cripple Creek. The concentrates produced from old tailings, and their gold and silver content, are included under "Concentrates produced." Comparison of the figures for 1910 and 1911 shows that the total quantity of this old material treated increased from 334,637 short tons in 1910 to 412,346 tons in 1911, but that the recovered gold content decreased from 30,323 to 16,259 fine ounces and the silver recovery from 333,809 to 99,475 fine ounces.

From this table the output of ore from the Central States, producing insignificant quantities of silver and no gold, has been omitted. The output of zinc ore from the Eastern States is also omitted, as this zinc ore produces no silver or gold.

The following table shows in summary the percentage of total output, by processes, of gold and silver in the United States in 1911:

*Percentage of output of gold and silver by processes in the United States in 1911.*

| Production by— | Percentage of total output. | |
|---|---|---|
| | Gold. | Silver. |
| Placers | 24.20 | 0.30 |
| Gold and silver mills: | | |
| By amalgamation | 23.90 | 1.54 |
| By cyanidation | 26.10 | 14.13 |
| By chlorination | 3.80 | ..... |
| Total milling | 53.80 | 15.67 |
| Smelting | 22.00 | 84.03 |
| Total | 100.00 | 100.00 |

In this table it is of interest to note that the mills contributed over half the gold output but less than 16 per cent of the silver production, and that the placers, the amalgamation and cyanidation processes, and the smelters mainly supplied the gold production in four nearly equal parts; but that the placers and the amalgamation process contributed very small percentages of the silver output, the chlorination process so small a fraction that it is not given, and the cyanidation process less than 15 per cent—the great bulk of the silver output, or more than 84 per cent, coming from the refining of smelting products.

The following table shows in greater detail the tonnage treated and output of precious metals by gold and silver mills, by States, in 1911:

*Quantity of ore treated at gold and silver mills in 1911, giving recoveries by amalgamation and cyanidation and percentage of each to gold and silver recovered from all sources.*

| State. | Ore and tailings treated. | Bullion recovered. | | | | Percentage of gold and silver from all sources. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Amalgamation. | | Cyanidation. | | Amalgamation. | | Cyanidation. | |
| | | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. |
| | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Fine ozs.* | *Fine ozs.* | | | | |
| Alaska | 1,594,404 | 118,483 | 14,343 | 81,959 | 8,942 | 14.7 | 3.12 | 10.1 | 1.9 |
| Arizona | 169,723 | 11,346 | 4,386 | 81,276 | 44,776 | 6.8 | 0.01 | 49.0 | 1.4 |
| California [a] | 2,259,047 | 353,443 | 141,131 | 42,108 | 52,756 | 37.0 | 11.11 | 4.1 | 4.4 |
| Colorado | 1,582,627 | 145,767 | 90,502 | 298,878 | 312,091 | 15.9 | 1.23 | 32.5 | 4.3 |
| Idaho | 114,461 | 15,312 | 13,753 | 19,914 | 266,319 | 23.3 | 0.02 | 30.0 | 3.3 |
| Montana | 249,120 | 12,643 | 15,902 | 43,104 | 106,921 | 7.4 | 0.01 | 24.0 | 0.9 |
| Nevada | 1,222,585 | 224,989 | 168,633 | 504,263 | 6,997,259 | 25.5 | 1.28 | 56.8 | 53.2 |
| New Mexico | 109,113 | 3,973 | 1,406 | 17,921 | 769,608 | 10.8 | 0.10 | 48.6 | 56.8 |
| Oregon [b] | 83,724 | 8,152 | 3,472 | 3,189 | 3,045 | 26.6 | 7.68 | 10.4 | 6.7 |
| South Dakota | 1,940,661 | 221,409 | 67,310 | 132,596 | 105,288 | 61.5 | 33.00 | 36.8 | 51.7 |
| Texas [c] | 21,644 | ..... | 418,166 | ..... | ..... | ..... | 98.50 | ..... | ..... |
| Utah | 267,111 | 785 | 1,029 | 29,527 | 111,464 | 0.3 | 0.01 | 13.0 | 0.9 |
| Washington | 11,846 | 1,982 | 681 | 1,502 | 2,221 | 4.9 | 0.28 | 3.7 | 0.9 |
| Wyoming | 1,447 | 576 | 98 | ..... | ..... | 62.0 | 13.51 | ..... | ..... |
| Appalachian States | 42,970 | 1,484 | 339 | 3,163 | 862 | 19.2 | 0.31 | 41.0 | 0.8 |
| Total [d] | 9,670,483 | 1,120,344 | 941,155 | 1,259,400 | 8,781,552 | 23.9 | 1.54 | 26.1 | 14.1 |

[a] Includes 102,097 tons old tailings.
[b] Includes 34,246 tons old tailings, cyanided.
[c] Pan amalgamation.
[d] Porto Rico and Philippines excluded.

Figures corresponding to those in this table have never before been compiled for States or for the country as a whole, and the Survey made special efforts to secure the information given for 1911. Comparisons can not be made, therefore, with data for preceding years.

As shown in this table, the total quantity of crude ore and old tailings treated in gold and silver mills in the United States in 1911 was 9,670,483 short tons.

The great bulk of the ore treated, as shown, was milled in California, South Dakota, Alaska, Colorado, and Nevada, and here the famous mills of the Mother Lode and Grass Valley, the Homestake, the Treadwell, and those of Cripple Creek and Goldfield and Tonopah are especially in evidence. Large numbers of other mills, however, mark the gold and silver mining industries in every mountain range and region where essentially gold and silver ores are mined. These plants range from small prospectors' mills with from 1 to 3 light stamps, simple amalgamating apparatus, and usually no concentrating tables, through the conventional 5-stamp, 10-stamp, 15-stamp, and 20-stamp mills—with plants varying widely according to local ore characteristics in weight and drop of stamps, rapidity and fineness of discharge, and arrangement for amalgamation and concentration—to the great mills above mentioned, which treat enormous tonnages daily and represent the high-water mark in milling and metallurgy of the precious metals, equipped as they are with intricate and beautifully balanced apparatus for sorting, crushing, sizing, classifying, grinding, concentrating, and amalgamation and cyanidation, and working with high extraction efficiency and admirable organization of labor and machines. The difficulties overcome in treating low-grade, refractory, and otherwise difficult ores, and the results achieved in recent years are a monument to American milling and metallurgy and an inspiration to the solution of the relatively few remaining problems of the art. From time to time new "processes" are

announced and advocated for the extraction of gold from low-grade or difficult ores, and although some of these are of great merit and mark signal advances in the art as demonstrated in actual practice in mining camps where their usefulness and applicability are undoubtedly proved, some of them are mainly advertised in regions where money is always to be had for "get-rich-quick" schemes and where personal knowledge of mining and metallurgy are so rare that frauds readily flourish.

The total production of gold by amalgamation in 1911 was 1,120,344 fine ounces, of which California, Nevada, South Dakota, Colorado, and Alaska mills furnished the greatest supply, in the order named. The total output of silver by amalgamation was 941,155 fine ounces, of which Texas, Nevada, California, and Colorado furnished the bulk, in the order given. The Texas recoveries are by pan amalgamation of silver ores, the other recoveries being mainly with the gold of gold-silver ores.

The total production of gold by cyanidation in 1911 was 1,259,400 fine ounces, the bulk of the output coming from Nevada, Colorado, South Dakota, Alaska, and Arizona, rapidly descending in the order named. The total output of silver by cyanidation was 8,781,552 ounces in 1911, of which Nevada alone supplied nearly 7,000,000 ounces, followed by New Mexico, Colorado, Idaho, Utah, Montana, and South Dakota, in the order given.

In addition to these recoveries by amalgamation and cyanidation the rapidly disappearing chlorination process yielded 181,206 fine ounces of gold in 1911, of which 160,937 ounces were recovered in Colorado, 20,006 ounces in California, and 263 ounces in South Carolina.

According to the percentages of the total output from all sources of gold and silver, it appears that amalgamation yielded 23.9 per cent of the gold and 1.54 per cent of the silver; that cyanidation supplied 26.1 per cent of the gold production and 14.1 per cent of the silver; and that chlorination produced 3.8 per cent of the gold output in 1911. In the various States interesting relative differences are shown by the table giving percentages of total output by amalgamation and cyanidation. In South Dakota 61.5 per cent of the gold was recovered by amalgamation and 36.8 per cent by cyanidation, leaving but 1.7 per cent recovered by placering and smelting combined. In Wyoming, California, Oregon, and Nevada percentages of gold above the average are recovered by amalgamation, and in Nevada, Arizona, New Mexico, the Appalachian States, South Dakota, Colorado, and Idaho percentages above the average by cyanidation. In silver recoveries Texas led with 98.5 per cent of the State output yielded by amalgamation, followed by South Dakota with 33 per cent. The production of silver in 1911 by cyanidation was 56.8 per cent of the State output in New Mexico, 53.2 per cent in Nevada, and 51.7 per cent in South Dakota. As shown in a preceding table the bulk of the silver output of the United States is not from milling but from smelting ores.

# COPPER.

By B. S. Butler.

## INTRODUCTION.

In the production of metallic copper suitable for commercial purposes three distinct processes are usually required, namely, mining, smelting, and refining. The Lake Superior native copper district is the only important producer where these three processes are not entirely distinct. It is possible, therefore, to ascertain the copper output of the country by collecting statistics from the mines, from the smelters, and from the refineries, and each of these sets of figures has its advantages and its disadvantages. The mine figures have the advantage of giving the most accurate distribution of the production but are less accurate in total quantity of copper recovered; the smelter figures permit of reasonably accurate distribution and also furnish the actual recovery of copper from the ores treated during the year; the refinery figures furnish the best measure of the copper made available for commercial uses during the year, but at this stage of manufacture the accurate distribution to the State of origin, or even the separation of copper derived from domestic and from foreign sources, is uncertain.

Statistics for 1911 showing the production of each of these stages of manufacture have been collected by the United States Geological Survey, and are presented in the following report.

Since the same material passes through the three processes of manufacture at successive periods, usually requiring two to three months from the time it is taken from the mine before it reaches the stage of refined copper, the year's production as recorded for the different stages does not represent the same materials—that is, the refinery production for the calendar year 1911 represents the mine production from about October 1, 1910, to October 1, 1911. The three sets of figures representing the successive stages of manufacture do not therefore necessarily agree, although they should not differ greatly if the condition of the industry is normal. The mine and the smelter figures will differ by the difference in the quantity of ore, matte, etc., in stock at the beginning and at the end of the year and by the difference in the quantity of copper reported by the mines and that recovered by the smelters. This difference is due to the fact that considerable copper is recovered from sulphur, lead, zinc, and siliceous ores carrying values in copper so low that the mines do not receive pay for and frequently do not report the copper content of the ore, although it is eventually recovered by the smelters. The

smelter and refinery figures will differ by the increase or decrease in stock of blister, etc., at the beginning and at the end of the year and by the loss in refining.

Since the smelter production permits reasonably accurate distribution as to source by States and also gives the actual output of copper, it is adopted in this report as the production of the country. It is made up of the production of blister copper and of furnace-refined or ingot copper of the Lake district.

## SUMMARY OF STATISTICS.

The following statistical statement summarizes the copper industry in the United States in 1910 and 1911:

*Summary of statistics of the copper industry in the United States in 1910 and 1911.*

| | 1910 | 1911 |
|---|---|---|
| Production of copper: | | |
| Smelter output.....pounds.. | 1,080,159,509 | 1,097,232,749 |
| Mine production.....do.... | 1,088,237,432 | 1,114,764,197 |
| Refinery production of new copper— | | |
| Electrolytic.....do.... | 782,171,204 | 823,507,764 |
| Lake.....do.... | 221,462,984 | 218,185,236 |
| Casting and pig.....do.... | 68,260,688 | 59,577,803 |
| Total domestic.....do.... | 1,071,894,876 | 1,101,270,803 |
| Total domestic and foreign.....do.... | 1,422,039,135 | 1,433,875,026 |
| Total new and old copper.....do.... | 1,610,000,000 | 1,648,000,000 |
| Total ore treated.....short tons.. | 28,517,556 | 29,994,942 |
| Copper ore treated.....do.... | 28,497,123 | 29,988,235 |
| Average yield of copper.....per cent.. | 1.88 | 1.825 |
| Imports.....pounds.. | 344,435,771 | 334,607,538 |
| Exports.....do.... | 708,316,543 | 786,553,208 |
| Consumption: | | |
| Total new copper.....do.... | 732,400,000 | 681,753,279 |
| Total new and old copper.....do.... | 941,400,000 | 895,900,000 |
| World's production.....do.... | 1,903,297,003 | 1,958,201,285 |
| Value of production in the United States..... | $137,180,257 | $137,154,092 |

*Production of copper in the United States in 1910 and 1911.*

[Smelter output, in pounds fine.]

| | 1910 | 1911 | | 1910 | 1911 |
|---|---|---|---|---|---|
| Alaska | 4,311,026 | 22,314,889 | Oregon | 22,022 | 125,943 |
| Arizona | 297,250,538 | 303,202,532 | Pennsylvania | 740,626 | 661,621 |
| California | 45,760,200 | 35,835,651 | Philippine Islands | 1,781 | 9,612 |
| Colorado | 9,307,497 | 9,791,861 | South Dakota | 43 | 1,607 |
| Georgia | 724 | | Tennessee | 16,691,777 | 18,965,143 |
| Idaho | 6,877,515 | 4,514,116 | Texas | 2,961 | 105 |
| Maryland | | 23,555 | Utah | 125,185,455 | 142,340,215 |
| Michigan | 221,462,984 | 218,185,236 | Vermont | 1,935 | |
| Missouri | | 640,411 | Virginia | 105,313 | |
| Montana | 283,078,473 | 271,814,491 | Washington | 65,021 | 195,503 |
| Nevada | 64,494,640 | 65,561,015 | Wyoming | 217,127 | 130,499 |
| New Hampshire | 12,409 | | Undistributed | [a] 603,570 | 44,645 |
| New Mexico | 3,784,609 | 2,860,400 | | | |
| North Carolina | 181,263 | 13,699 | Total | 1,080,159,509 | 1,097,232,749 |

[a] Includes Missouri.

## GENERAL CONDITION OF INDUSTRY.

In production 1911 was a year of prosperity, both smelter and refinery outputs being the largest in the history of the industry. This increase, however, was due to the entrance of new producers into

the field, as several of the older districts made smaller productions, the decrease generally being due to curtailment on account of the unsatisfactory condition of the copper metal market. The average price of copper for the year, 12.5 cents a pound, was slightly below that of 1910 and the lowest yearly average price since 1902. Near the close of the year, however, the price of copper was notably better, the average for December being 13.71 cents a pound; and the stocks of copper that were large at the beginning of the year had been also materially reduced. Metal market conditions continued to improve till the average price in July, 1912, rose above 17 cents a pound, the highest price since the panic in 1907.

Several companies that will be large producers began to contribute to the output in 1911. Among the more important of these are the Miami Copper Co., in the Globe district, Ariz.; the Ray Consolidated Copper Co., of the Mineral Creek district, Ariz.; the Chino Copper Co., of the Santa Rita district, N. Mex.; and the Bonanza mine of the Copper River district, Alaska. Production from the Yerington district of Nevada began early in 1912.

Several of the older districts voluntarily curtailed their outputs, and there was a material reduction in the Shasta County, Cal., district, due to "smelter fume" difficulties.

Domestic consumption of copper for the year was less than for 1910, but the export was considerably larger, the sum of the two exceeding the production, so that stocks of copper had been considerably reduced at the close of the year.

The companies entering the producing list during the year made relatively small outputs, none of them reaching their full capacity in production, so that the 1912 output should show a material increase, though it will not be till 1913 that the full increase in producing capacity will be felt.

## GEOLOGICAL CLASSIFICATION OF COPPER DEPOSITS.

### BASIS OF CLASSIFICATION.

The geological classification of copper deposits is of interest as well as the metallurgical classification. From a statistical standpoint, such a classification is somewhat difficult for the reason that in a single district two or more types may occur and in some instances the amount of copper derived from each has not been recorded. The approximate amount derived from the several types can, however, usually be ascertained.

It is apparent that from a statistical standpoint only broad groups can be recognized as the data are not available for ascertaining the output from types of minor commercial importance, although they may be of great scientific interest.

A classification may be made on the basis of the geologic age of the deposits which is usually the same for all deposits in a given district, which method groups together deposits differing greatly in mineralogical character and geologic occurrence; or, on the other hand, a classification may be based on geologic occurrence and mineralogical character, by which method deposits of widely separated ages are thrown into the same group.

## CLASSIFICATION ACCORDING TO GEOLOGIC AGE.

Lindgren[1] has given an age classification of metalliferous ores to which the copper deposits of the United States of known age may be readily referred, although unfortunately there are some of the deposits whose age has not been positively determined.

In varying quantity copper minerals are of widespread and general occurrence both in geographic distribution and in geologic age. It is doubtful if there has been an important period of deposition of metallic minerals, with the exception of iron ores, in which copper minerals have not been deposited to a greater or less extent. In spite of this very universal distribution of the metal, all the deposits of known age that have made important contributions to the country's output can be referred to four periods which in general correspond to periods of igneous activity.

*Pre-Cambrian periods.*—The pre-Cambrian, covering as it does a very long portion of geologic time, probably includes deposits formed at widely separated times and certainly of wide geographic distribution and of very different character. The important deposits of this age that have been developed to the present time are, however, few in number. The larger producers have been the Lake Superior district of Michigan, the Jerome district of Arizona, and the Encampment district of Wyoming; some lesser deposits in the West and possibly some of the Appalachian deposits should be classed with them. Deposits of this age have yielded approximately 34 per cent of the total output of the country, and they yielded about 23 per cent of the 1911 output.

*Paleozoic era.*—The deposits of this era are confined to the Appalachian region. They were formerly considered to be of pre-Cambrian age, but it is now known that several of the Appalachian deposits occur in metamorphosed sediments of early or middle Paleozoic age, and it is probable that the same age will be shown for the inclosing rock of more of them. The time in the Paleozoic when the deposits were formed is somewhat uncertain. Some of them have been described by geologists as being formed before the great period of regional metamorphism which is believed to have occurred in the late Paleozoic; other investigators in studying other deposits have found that the ores were formed after the period of metamorphism. From these descriptions one is led to the conclusion that deposition of copper ore both preceded the regional metamorphism and also followed it. As the data are not now available for a separation of these, they will be considered together—and, indeed, it may be found that most of the deposits were formed during the period of metamorphism. The most important production has been made from the Ducktown district of Tennessee, the Great Gossan lead of Virginia and North Carolina, the Virginia district of Virginia and North Carolina, and the Ely district of Vermont. Deposits of this age have yielded between 1.5 and 2 per cent of the output of the country, and they produced about 1.8 per cent of the 1911 output.

*Mesozoic era.*—The third important period of copper deposition occurred in the Mesozoic era, preceding the main deposition of Cretaceous sediments and probably at about the close of the Jurassic or

[1] Lindgren, Waldemar, Metallogenetic epochs: Jour. Geology, vol. 4, 1896, p. 409.

in the early Cretaceous. These deposits are associated with the great masses of monzonitic and dioritic intrusives that extend through the far Western States from British Columbia on the north to Mexico on the south.

Among the more important of these deposits are those of the Shasta district and the "Foothills" district of California, together with numerous districts of Idaho, eastern Washington, and western Nevada, which have not made important production, and the deposits in Alaska. To this general period are assigned the deposits of the Bisbee district, Arizona. Ransome considers that the deposits at Globe, Ariz., are probably of this age, though the field evidence is not conclusive and they may prove to be of the same age as the very similar deposits at Morenci, Ariz., and Santa Rita, N. Mex. It is probable that the deposits of the Ray district and possibly of the Silverbell district, Arizona, will prove to be of the same age as the deposits at Globe. Spencer considers the deposits of the Ely district, Nevada, to be of this age.

If the deposits enumerated above are correctly assigned, the output from ores of this age amounts to nearly 16 per cent of the total output of the country and about 28.5 per cent of the production in 1911.

*Tertiary period.*—The fourth important period of copper deposition occurred in Tertiary time and was associated with the extensive granitic and monzonitic intrusions in the Rocky Mountain and eastern Great Basin regions extending from Montana on the north to Mexico on the south. The exact age of these intrusions and the associated ore deposits can not always be fixed, but the intrusives cut Cretaceous rocks and in some instances Miocene rocks, and it is probable that the deposits are from early to middle Tertiary and possibly some of them late Tertiary in age.

To this period are assigned the deposits of Butte, Mont., of the Morenci-Metcalf district, Arizona, of the Santa Rita district, New Mexico, and probably the deposits of the Bingham and Frisco districts, Utah, together with many deposits of mixed lead-silver-copper ores in Colorado, Utah, and New Mexico that have yielded considerable copper. If the age assigned to the deposits included in this period is correct, ores of this age have yielded about 46.5 per cent of the total output of the country, and they produced about 45 per cent of the output in 1911. So far as indicated by past and present production this was the most important of the epochs of copper deposition.

*Other periods.*—In addition to these deposits and periods mentioned there are deposits along the Pacific coast associated with basic igneous rocks of early Mesozoic age. These deposits have not yielded important quantities of copper. In the east the copper deposits associated with the Triassic traps may be mentioned, though the copper derived from them is unimportant. There is a widespread occurrence of what Lindgren has designated "Cretaceous and later concentrations in sedimentary rocks." Deposits of this character occur largely in the "Red Beds" in Arizona, New Mexico, Utah, Colorado, and Texas, and although they have been of little commercial importance in the past there is a possibility of their proving a source of production at some future time.

## CLASSIFICATION ACCORDING TO OCCURRENCE.

From the standpoint of mineral composition and geologic occurrence, the copper deposits may be grouped into six principal classes and the approximate quantity derived from each group may be ascertained. In a general way, this grouping also classifies the ores according to the metallurgical treatment to which they are best adapted.

In a classification of this kind that is adapted to a general statistical treatment, it is apparent that too fine distinctions can not be drawn, since the necessary data are not available, and in some districts where copper has been derived from more than one type of deposit it is not possible to obtain exact figures of the output of each. Moreover, even in a very general classification, there is uncertainty in the case of some deposits as to which type they should be assigned.

The following grouping is presented as of interest from a statistical standpoint but is not suggested as an adequate classification of copper ores where data are available for greater refinement:

*Lenticular deposits in schistose and igneous rocks.*—Under this head are considered deposits, whose primary mineralization consisted mainly of sulphide of iron, copper, and zinc, replacing schistose rocks. The schistosity may be either the result of regional metamorphism or of the local shearing of igneous rocks. This class of deposit usually has a more or less lenticular form. The primary ores are generally a rather low-grade smelting ore but are susceptible of cheap mining and metallurgical treatment. In many instances the upper part of these deposits contain a zone of enriched sulphides. To this type may be referred the deposits of the Jerome district, Arizona; the "Foothill" and Shasta County districts, California; the Ducktown district, Tennessee; many smaller deposits in the Appalachian region, including deposits in New Hampshire, Vermont, Virginia, Alabama, and Georgia, and the deposits of the Prince William Sound district, Alaska. The output from this type of deposit has been about 8.5 per cent of the total from the country; in 1911 it was about 8.4 per cent.

*Native copper in volcanic rocks.*—Under this type are grouped deposits in which the copper occurs native in irregular ore shoots in certain beds of volcanic or interbedded volcanic and sedimentary rocks. The ores are nearly all of a concentrating grade, the "mineral" resulting from the concentration being subjected to a special refining process. The Lake Superior district, Michigan, is the only one of this type that has made important production, though similar deposits occur in Pennsylvania, Maryland, New Jersey, and Alaska. The output from this type is essentially that of the Lake Superior district. It has contributed 30.35 per cent of the total output and constituted 19.89 per cent of the production in 1911.

*Replacement deposits in sedimentary rocks.*—Under this heading are included what are commonly known as contact deposits and deposits formed by the replacement of sediments along fissures. The primary mineralization in this type consists of iron and copper sulphides, together with varying amounts of other sulphides, oxides, and silicates, usually replacing limestone or other highly calcareous rocks. Secondary alteration has frequently been extensive in these deposits and much of the copper has been derived from oxidized

ores. Most of the ores are of smelting grade. Some of the oxidized ores carry high copper values, and the primary sulphide ores, though relatively low in copper content, are cheaply treated. To this type of deposit may be referred the output of the Bisbee and Silverbell districts, and part of the Globe and Morenci-Metcalf districts, Arizona; part of the production from Bingham, Utah; Santa Rita, N. Mex.; Ely, Nev.; southeastern Alaska; the Copper River district, Alaska; and many smaller districts. To this type also belongs the output from many lead-silver districts in which copper is of minor importance. Among these are Leadville, Colo., Tintic and Park City, Utah, and many others.

The output from this type of ore has been approximately 18 per cent of the total and was about 22 per cent of the production in 1911.

*Disseminated deposits.*—Under this type are considered deposits in which the ore minerals occur in small veins or grains disseminated through altered igneous, schistose, or sedimentary rocks. This includes what are frequently referred to as "porphyry" ores. The term "disseminated" is preferable, since many of the ores of this type do not occur in porphyritic rocks.

The primary mineralization commonly consists of pyrite and chalcopyrite with varying quantities of other sulphides. The deposits have usually undergone secondary sulphide enrichment, the copper content of the minerals near the surface being taken in solution and redeposited, usually as chalcocite, on the sulphides lower down. In some instances deposits of this type that have not been enriched are worked, and in still others native copper and cuprite are among the important ore minerals. The ore is usually low-grade concentrating ore, but it occurs in large bodies and is cheaply mined and milled.

Any separation of this type from that of replacement fissure-vein deposits must be purely arbitrary, but it seems desirable to make such a separation. The principal deposits of this type are those of the Bingham and Frisco districts, Utah; Ely district, Nevada; Morenci-Metcalf, Miami, and Ray districts, Arizona; Santa Rita, N. Mex., and others that may prove of future importance. The output from this type of deposit, which has been produced largely during the last few years, is approximately 7 per cent of the total and was about 23 per cent of the production in 1911.

*Fissure-vein deposits.*—Under this type are included deposits formed in fissure veins and as a replacement along such veins. As already stated, there is no sharp line between this type and that of the disseminated deposits. In the case of the principal deposits of this type, those at Butte, Mont., much of the ore is of a smelting grade, and there are other differences that make it desirable to keep it separate from the disseminated deposits. The primary mineralization of this class consists of sulphides of iron, copper, and zinc in varying amounts, with small amounts of other sulphides filling fissures and replacing the wall rocks. Secondary enrichment in this type as in the preceding has been important in producing the commercial ore. The ores are of both smelting and concentrating grades.

The great deposit of this type is that at Butte, Mont., though smaller deposits occur in many places in the West and to some extent in the Appalachian region. The output from this type is approximately 35 per cent of the total and was about 25 per cent of the production in 1911.

*Disseminated deposits in sedimentary rocks.*—To the classes named should be added the disseminated deposits in little altered or unaltered sedimentary rocks, usually referred to as the "Red Beds" deposits. In this class the primary mineralization ordinarily consists of chalcocite disseminated through sandstones, shale, and conglomerate. This may be partly or entirely altered to carbonates, oxides, and silicates. This type has not yielded important amounts of copper in this country, but the deposits are numerous, especially in Texas, New Mexico, Arizona, Colorado, and Utah, and they may prove of commercial importance at some future time.

## PRODUCTION.

### SMELTER AND MINE PRODUCTION.

#### GENERAL STATEMENT.

The production of copper in 1911 by smelters from copper-bearing materials from the United States was 1,097,232,749 pounds, valued at $137,154,092,[a] as compared with 1,080,159,509 pounds, valued at $137,180,257, in 1910. The production for 1911 was the largest in the history of the industry, surpassing that of 1910 by about 1.5 per cent.

The yearly production of copper in the United States from 1845 to 1911, inclusive, together with the actual and relative changes from each preceding year, is shown in the following table:

*Magnitude and growth of copper production in the United States from 1845 to 1911, inclusive.*

| Year. | Production. | Increase. | | Average annual increase, by decades. | |
|---|---|---|---|---|---|
| | *Pounds.* | *Pounds.* | *Per cent.* | *Pounds.* | *Per cent.* |
| 1845 | 224,000 | | | | |
| 1846 | 336,000 | 112,000 | 50.0 | | |
| 1847 | 672,000 | 336,000 | 100.0 | 246,400 | 50.0 |
| 1848 | 1,120,000 | 448,000 | 67.0 | | |
| 1849 | 1,568,000 | 448,000 | 40.0 | | |
| 1850 | 1,456,000 | b 112,000 | b 7.1 | | |
| 1851 | 2,016,000 | 560,000 | 38.4 | | |
| 1852 | 2,464,000 | 448,000 | 22.2 | | |
| 1853 | 4,480,000 | 2,016,000 | 81.8 | | |
| 1854 | 5,040,000 | 560,000 | 12.5 | | |
| 1855 | 6,720,000 | 1,730,000 | 33.3 | 1,472,200 | 28.5 |
| 1856 | 8,960,000 | 2,240,000 | 33.3 | | |
| 1857 | 10,752,000 | 1,792,000 | 20.0 | | |
| 1858 | 12,320,000 | 1,568,000 | 14.6 | | |
| 1859 | 14,112,000 | 1,792,000 | 14.5 | | |
| 1860 | 16,128,000 | 2,016,000 | 14.3 | | |
| 1861 | 16,800,000 | 672,000 | 4.1 | | |
| 1862 | 21,160,000 | 4,360,000 | 26.0 | | |
| 1863 | 19,040,000 | b 2,120,000 | 10.0 | | |
| 1864 | 17,920,000 | b 1,120,000 | b 5.9 | | |
| 1865 | 19,040,000 | 1,120,000 | 6.3 | 1,209,600 | 6.2 |
| 1866 | 19,936,000 | 896,000 | 4.7 | | |
| 1867 | 22,400,000 | 2,464,000 | 12.3 | | |
| 1868 | 25,984,000 | 3,584,000 | 16.0 | | |
| 1869 | 28,000,000 | 2,016,000 | 7.7 | | |
| 1870 | 28,224,000 | 224,000 | .8 | | |
| 1871 | 29,120,000 | 896,000 | 3.2 | | |
| 1872 | 28,000,000 | b 1,120,000 | b 3.8 | | |
| 1873 | 34,720,000 | 6,720,000 | 24.0 | | |
| 1874 | 39,200,000 | 4,480,000 | 12.9 | | |
| 1875 | 40,320,000 | 1,120,000 | 2.9 | 3,225,600 | 8.2 |
| 1876 | 42,560,000 | 2,240,000 | 5.6 | | |
| 1877 | 47,040,000 | 4,480,000 | 10.0 | | |
| 1878 | 48,160,000 | 1,120,000 | 2.4 | | |
| 1879 | 51,520,000 | 3,360,000 | 7.0 | | |
| 1880 | 60,480,000 | 8,960,000 | 17.4 | | |

[a] For discussion of prices, see section on prices on a subsequent page. [b] Decrease.

*Magnitude and growth of copper production in the United States from 1845 to 1911, inclusive*—Continued.

| Year. | Production. | Increase. | | Average annual increase, by decades. | |
|---|---|---|---|---|---|
| | *Pounds.* | *Pounds.* | *Per cent.* | *Pounds.* | *Per cent.* |
| 1881 | 71,680,000 | 11,200,000 | 18.5 | | |
| 1882 | 90,646,232 | 8,966,232 | 12.5 | | |
| 1883 | 115,526,053 | 24,886,221 | 27.4 | | |
| 1884 | 144,946,653 | 29,420,600 | 25.5 | | |
| 1885 | 165,875,766 | 20,929,113 | 14.4 | 18,928,949 | 14.8 |
| 1886 | 156,735,381 | a 9,140,385 | a 5.5 | | |
| 1887 | 180,920,524 | 24,185,143 | 15.4 | | |
| 1888 | 226,361,466 | 45,440,942 | 25.0 | | |
| 1889 | 226,775,962 | 414,496 | .2 | | |
| 1890 | 259,763,092 | 32,987,130 | 14.5 | | |
| 1891 | 284,121,764 | 24,358,672 | 9.4 | | |
| 1892 | 344,998,679 | 60,876,915 | 21.4 | | |
| 1893 | 329,354,398 | a 15,644,281 | a 4.5 | | |
| 1894 | 354,188,374 | 24,833,976 | 7.5 | | |
| 1895 | 380,613,404 | 26,425,030 | 7.4 | 34,635,407 | 9.4 |
| 1896 | 460,061,430 | 79,448,026 | 20.0 | | |
| 1897 | 494,078,274 | 34,016,844 | 7.4 | | |
| 1898 | 526,512,987 | 32,434,713 | 6.6 | | |
| 1899 | 568,666,921 | 42,153,934 | 8.0 | | |
| 1900 | 606,117,166 | 37,450,245 | 6.6 | | |
| 1901 | 602,072,519 | a 4,044,647 | a .7 | | |
| 1902 | 659,508,644 | 57,436,125 | 9.5 | | |
| 1903 | 698,044,517 | 38,535,873 | 5.8 | | |
| 1904 | 812,537,267 | 114,492,750 | 16.4 | | |
| 1905 | 888,784,267 | 76,247,000 | 11.0 | 47,404,234 | 6.1 |
| 1906 | 917,805,682 | a 15,897,839 | 1.7 | | |
| 1907 | 868,996,491 | a 48,809,191 | a 5.3 | | |
| 1908 | 942,570,721 | 73,074,230 | 8.4 | | |
| 1909 | 1,092,951,624 | 150,380,903 | 15.9 | | |
| 1910 | 1,080,159,509 | a 12,792,115 | a 1.2 | | |
| 1911 | 1,097,232,749 | 17,073,240 | 1.6 | | |
| Total | 16,376,600,516 | | | | |

a Decrease.

The figures, except for 1911, are taken from the previous volumes of Mineral Resources of the United States. Statistics from 1882 to 1910, inclusive, are based on the returns to the United States Geological Survey by the copper-producing companies. Figures for the years prior to 1882 were compiled by the Survey from the best sources available. Reliable figures for years previous to 1845 are not obtainable. The year 1845, however, marks the entrance of the Lake Superior district into the ranks of producers and is really the beginning of important production of copper in this country. The industry has shown a steady and, since 1880 when Arizona and Montana became important producers, a very rapid growth.

Only five times since 1880 has the annual production shown a decrease from that of the preceding year and in every instance the decrease has been slight and has been more than recovered the following year. The years showing a decrease are 1886, 1893, 1901, 1907, and 1910. At several other times the increase has been slight. In most instances where there has been a decrease it may be attributed to a general condition of financial and business depression, which has resulted in a decrease in the demand for copper and other materials necessary to the expansion of industries. In two instances a slight decrease appears to have been due to the fact that the producing capacity of the country had been increased out of proportion to the demand for domestic consumption and export, and a temporary curtailment in production became necessary to permit the absorption of accumulated stocks. This, coupled with attempts at artificial control of prices, appears to have been the case in 1886 and also in 1901.

The decreases in 1893 and in 1907, which were the most pronounced in the history of the industry, were, of course, due to the widespread condition of financial and business depression of those years. The decrease in production in 1910 can be attributed to the great increase in the producing capacity of this and other countries during the last few years, which has outstripped the normal growth in consumption; though for the last two years both domestic consumption and exports have been the largest in the history of the industry. This excessive production resulted in 1910 in the accumulation of large stocks of copper in various stages of manufacture, which it was found necessary to reduce by curtailing the current production.

During 1911 domestic consumption and exports of copper exceeded production, so that at the close of the year there had been a material reduction in the stocks of copper as compared with 1910, in spite of the record production.

## SMELTER RETURNS.

The figures of smelter production for 1911 are based on returns made confidentially to the United States Geological Survey by all known smelting companies handling copper-bearing materials from the United States. To all companies and officials who have aided in furnishing this information and have given valuable time to answering inquiries to secure the accurate distribution of the output, sincere thanks are extended. The following list gives the names of the owning or operating companies, the location, and the final copper product of smelting and refining plants treating material from the United States during 1911. It does not include lead and zinc plants that recovered copper as a by-product from mixed ores. Lists of lead and zinc smelters can be found in the reports on those metals.

*Copper smelting plants that treated materials from the United States in 1911.*

| Location. | Company. | Final copper product. |
|---|---|---|
| UNITED STATES. | | |
| Arizona: | | |
| Clifton | Arizona Copper Co | Blister. |
| Do | Shannon Copper Co | Do. |
| Douglas | Calumet & Arizona Mining Co | Do. |
| Do | Copper Queen Consolidated Mining Co | Do. |
| Globe | Old Dominion Copper Mining & Smelting Co | Do. |
| Humboldt | Consolidated Arizona Smelting Co | Do. |
| Jerome | United Verde Copper Co | Do. |
| Morenci | Detroit Copper Mining Co | Do. |
| Swansea | Clara Consolidated Gold & Copper Co | Do. |
| California: | | |
| Campo Seco | Penn Mining Co | Matte. |
| Coram | First National Copper Co | Blister. |
| Kennett | Mammoth Copper Mining Co | Do. |
| Martinez | Mountain Copper Co | Do. |
| Needles | Needles Smelting & Refining Co | Matte. |
| Colorado: | | |
| Golden | North American Smelting & Mines Co | Do. |
| Salida | Ohio & Colorado Smelting & Refining Co | Do. |
| Idaho: Ivers | Lost Packer Mining Co | Do. |
| Maryland: Baltimore | Baltimore Copper Smelting & Rolling Co.[a] | Electrolytic |
| Michigan: | | |
| Hancock | Lake Superior Smelting Co | Anodes and lake. |
| Do | Quincy Mining Co | Do. |
| Houghton | Michigan Smelting Co | Do. |
| Hubbell | Calumet & Hecla Mining Co | Do. |
| Montana: | | |
| Anaconda | Anaconda Copper Mining Co | Blister. |
| Butte | East Butte Copper Mining Co | Do. |
| Great Falls | Anaconda Copper Mining Co | Blister and electrolytic. |

[a] Subsidiary of American Smelters Securities Co.

*Copper smelting plants that treated materials from the United States in 1911*—Contd.

| Location. | Company. | Final copper product. |
|---|---|---|
| UNITED STATES. | | |
| Nebraska: Omaha | American Smelting & Refining Co | Blister. |
| Nevada: McGill | Nevada Consolidated Copper Co | Do. |
| New Jersey:[a] | | |
| Chrome | United States Metals Refining Co | Electrolytic and casting. |
| Maurer | American Smelting & Refining Co | Electrolytic. |
| Newark | Balbach Smelting & Refining Co | Electrolytic and casting. |
| Perth Amboy | Raritan Copper Works | Electrolytic. |
| New York: | | |
| Black Rock | Buffalo Smelting Works | Lake and electrolytic. |
| Laurel Hill | Nichols Copper Co | Electrolytic and casting. |
| Tennessee: | | |
| Copperhill | Tennessee Copper Co | Blister. |
| Isabella | Ducktown Sulphur, Copper & Iron Co. (Ltd.) | Matte. |
| Texas: El Paso | American Smelting & Refining Co | Do. |
| Utah: | | |
| Garfield | Garfield Smelting Co.[b] | Blister. |
| International | International Smelting & Refining Co | Do. |
| Washington: Tacoma | Tacoma Smelting Co.[b] | Blister and electrolytic. |
| CANADA. | | |
| British Columbia: | | |
| Trail | Consolidated Mining & Smelting Co. of Canada | Matte. |
| Ladysmith | Tyee Copper Co. (Ltd.) | Do. |
| Grand Forks | Granby Consolidated Mining, Smelting & Power Co. | Blister. |
| MEXICO. | | |
| Aguas Calientes: Aguas Calientes. | American Smelting & Refining Co | Do. |
| Cananea | Cananea Consolidated Copper Co | Do. |

[a] This list does not include a smelter in New Jersey and one in Pennsylvania, both of which make blister from material solely of foreign origin.
[b] Subsidiary of American Smelters Securities Co.

During the year 44 copper smelting and refining plants treated material from the United States. Of these, 39 were domestic plants and 5 were foreign—3 located in British Columbia and 2 in Mexico.

The figures of production represent the actual smelter recovery. For Michigan it is the sum of furnace-refined copper and copper cast into anodes for electrolytic refining. In the case of blister copper the figures represent the fine copper content. Some casting copper is produced direct from ore and matte and this is included in the smelter production.

The following table shows approximately the production of blister copper from different sections. Smelters that produced only matte are not included in this distribution.

*Production of copper in 1911, apportioned according to locality in which smelted to blister, in pounds.*

| Locality. | Domestic. | Foreign. | Total. |
|---|---|---|---|
| Arizona | 271,000,000 | 25,600,000 | 296,600,000 |
| Montana | 272,700,000 | ..... | 272,700,000 |
| Utah and Nevada | 201,500,000 | ..... | 201,500,000 |
| California and Washington | 48,000,000 | 15,000,000 | 63,000,000 |
| All others | 263,000,000 | 58,000,000 | 321,000,000 |
| Total by domestic plants | 1,056,200,000 | 98,600,000 | 1,154,800,000 |
| Total by foreign plants from domestic ore and matte | 41,000,000 | ..... | ..... |
| Grand total from domestic ores | 1,097,200,000 | ..... | ..... |

As will be seen by comparing this table with the table showing the production by States and districts, ore, with few exceptions, is reduced to blister copper before being shipped from the district. The excep-

tions in the case of important producing States are Michigan and Colorado. In the case of Michigan the shipping product is high-grade concentrate transported by Lake boats to Buffalo at a low cost; in the case of Colorado the copper is largely produced in lead furnaces and is shipped to Omaha for conversion. Considerable matte produced in California is shipped east for conversion.

Arizona treated considerable Mexican ore, and ore and matte from British Columbia were treated in this country. Ore and matte from the United States was smelted in Mexico, and ore from the United States was smelted in British Columbia and returned to this country. A large tonnage of ore and matte from foreign sources was treated by the seaboard smelters.

During 1911 matte smelters produced a total of about 40,800,000 pounds of copper, as compared with 41,250,000 pounds produced in 1910. In most instances the product of these plants is shipped to near-by blister smelters for conversion.

## MINE RETURNS.

The figures of mine production are based on reports furnished to the United States Geological Survey by all mines producing copper in 1911. These mines reported 1,114,769,197 pounds of copper, or 17,537,448 pounds more than the smelters. The mines and smelters of the large copper producers are, with few exceptions, under the same management and their production is thought to be reported on the same basis. In the case of mines that ship to custom smelters or have only matting furnaces and ship their matte for conversion there is likely to be considerable discrepancy, as the mines may report a considerable quantity that has not reached the stage of blister by the close of the year and is consequently not included in the smelter production, or material that was reported by the mines in one year may be treated by the smelters the following year. This discrepancy is more pronounced if a marked curtailment of production occurs at the beginning or at the close of the year, so that there is not the balance of overlap that occurs if the industry is in normal condition throughout the year. A number of operators report the copper in their ores and concentrates on the basis of assay content, in which case it exceeds the smelter recovery from the same material by the amount lost in smelting. Considerable copper is recovered by the smelters from ores that are treated primarily for other metals, the copper content being so low that it is not paid for, and consequently is not always reported by the mines.

The following table shows the output of copper from domestic ores for the last six years as reported by mines, smelters, and refineries:

*Production of copper from domestic ores as reported by the mines, the smelters, and the refineries, 1906–1911, in pounds.*

| Year. | Mine. | Smelter. | Refinery. |
|---|---|---|---|
| 1906 | 916,971,387 | 917,805,682 | 887,682,387 |
| 1907 | 847,151,015 | 868,996,491 | 784,271,427 |
| 1908 | 956,840,578 | 942,570,721 | 919,111,414 |
| 1909 | 1,126,521,126 | 1,092,951,624 | 1,065,564,921 |
| 1910 | 1,088,237,432 | 1,080,159,509 | 1,071,894,876 |
| 1911 | 1,114,764,197 | 1,097,232,749 | 1,101,270,803 |
| Total | 6,050,485,735 | 5,999,716,774 | 5,829,795,828 |

As shown by this table, in the period of six years the quantity of copper reported by the mines exceeded that reported by the smelters by about 0.8 per cent. This difference can be accounted for in part by an increase in stocks of ore and concentrates at the smelting plants. At the beginning of the period there was an urgent demand for copper, and the smelters and refineries were turning out the final product as rapidly as possible, only such stocks being carried as were actually necessary. At the close of the period the demand for refined copper was less active, and many of the smelting companies were carrying considerable reserve stocks of ore and concentrates.

The difference between the smelter and the refinery production is accounted for entirely by an increase in the stocks of blister copper plus the copper content of bluestone produced and the loss in refining.

It appears that although theoretically the output reported by the mines should be considerably in excess of that reported by the smelters, this difference in the last six years has been nearly balanced by the copper recovered from lead, zinc, gold, silver, and sulphur ores which carry copper values so low that they are not paid for and consequently have not usually been reported by the mines.

## PRODUCTION BY STATES.

Twenty-one States and Territories contributed to the copper production of 1911. The following table shows the mine and the smelter output of individual States for 1910 and 1911.

According to smelter returns, the three leading States, Arizona, Montana, and Michigan, produced 72 per cent of the total output of 1911, as compared with 74 per cent in 1910, the six leading States, including Utah, Nevada, and California, produced over 94 per cent of the total output in 1911, as compared with over 96 per cent in 1910.

*Production of copper by smelter returns in 1910 and 1911, compared with mine returns for same years, by States, in pounds.*

| State. | Production. | | | | | |
|---|---|---|---|---|---|---|
| | 1911 | | | | 1910 | |
| | Rank. | Percentage of total. | Smelter returns. | Mine returns. | Smelter returns. | Mine returns. |
| Alaska | 7 | 2.03 | 22,314,889 | 27,267,878 | 4,311,026 | 4,241,689 |
| Arizona | 1 | 27.63 | 303,202,532 | 306,141,538 | 297,250,538 | 297,491,151 |
| California | 6 | 3.27 | 35,835,651 | 36,316,136 | 45,760,200 | 48,700,756 |
| Colorado | 9 | .89 | 9,791,861 | 8,024,488 | 9,307,497 | 8,359,535 |
| Georgia | | | | | 724 | |
| Idaho | 10 | .41 | 4,514,116 | 5,152,937 | 6,877,515 | 7,037,292 |
| Maryland | 18 | | 23,555 | (a) | | |
| Michigan | 3 | 19.89 | 218,185,236 | 219,840,201 | 221,462,984 | 222,683,461 |
| Missouri | 13 | .06 | 640,411 | 640,411 | | |
| Montana | 2 | 24.71 | 271,814,491 | 272,847,705 | 283,078,473 | 284,808,553 |
| Nevada | 5 | 5.98 | 65,561,015 | 67,377,518 | 64,494,640 | 64,359,398 |
| New Hampshire | | | | | 12,409 | 12,409 |
| New Mexico | 11 | .26 | 2,860,400 | 4,057,040 | 3,784,609 | 4,614,386 |
| North Carolina | 19 | | 13,699 | | 181,263 | 140,514 |
| Oregon | 16 | .01 | 125,943 | 93,136 | 22,022 | 13,861 |
| Pennsylvania | 12 | .06 | 661,621 | a 665,110 | 740,626 | 927,360 |
| Philippine Islands | 20 | | 9,612 | 2,205 | 1,781 | |
| South Dakota | 21 | | 1,607 | | 43 | |
| Tennessee | 8 | 1.72 | 18,965,143 | 18,850,276 | 16,691,777 | 16,837,727 |
| Texas | 22 | | 105 | | 2,961 | 3,157 |
| Utah | 4 | 12.97 | 142,340,215 | 146,960,827 | 125,185,455 | 127,597,072 |
| Vermont | | | | | 1,935 | |
| Virginia | | | | 90,000 | 105,313 | 5,402 |
| Washington | 14 | .02 | 195,503 | 318,207 | 65,021 | 86,918 |
| Wyoming | 15 | .01 | 130,499 | 118,584 | 217,127 | 222,339 |
| Unapportioned | 17 | | 44,645 | | b 603,570 | 94,452 |
| Total | | | 1,097,232,749 | 1,114,764,197 | 1,080,159,509 | 1,088,237,432 |

a Pennsylvania and Maryland combined. b Includes Missouri.

In the distribution of the blister output to the States of origin it is necessary to have reports not only from blister producers but also from matte smelters, as the matte is credited by the smelter that converts it to the State from which it was received, although the matte smelter may have received its ores from several States. In the adjustment of the products of these matte smelters slight errors in the distribution of the blister production are probably introduced.

The following table shows the production from 1902 to 1911 for each State for which separate statistics are available.

In the report for 1910 the production by States since 1845 is given. This report can be secured on application to the Director of the United States Geological Survey, Washington, D. C.

*Production of copper in the United States, 1902–1911, by States, in pounds.*

| State. | 1902 | 1903 | 1904 | 1905 | 1906 |
|---|---|---|---|---|---|
| Alaska | ..... | 1,339,590 | 2,043,586 | 4,900,866 | 8,685,646 |
| Arizona | 119,944,944 | 147,648,271 | 191,602,958 | 226,854,461 | 262,566,103 |
| California | 25,038,724 | 17,776,756 | 28,529,023 | 16,697,489 | 28,153,202 |
| Colorado | 8,422,030 | 4,158,368 | 9,506,944 | 9,404,830 | 7,427,253 |
| Idaho | 227,500 | 778,906 | 2,158,858 | 7,321,585 | 8,578,046 |
| Michigan | 170,609,228 | 192,400,577 | 208,309,130 | 230,287,992 | 229,695,730 |
| Montana | 288,903,820 | 272,555,854 | 298,314,804 | 314,750,582 | 294,701,252 |
| New Mexico | 6,614,961 | 7,300,832 | 5,368,666 | 5,334,192 | 7,099,842 |
| Nevada | 164,301 | 150,000 | ..... | 413,292 | 1,090,635 |
| Oregon | ..... | ..... | ..... | 846,615 | 545,859 |
| South Dakota | 445,663 | 173,202 | 100,000 | 38 | ..... |
| Utah | 23,939,901 | 38,302,602 | 47,062,889 | 54,083,506 | 50,329,119 |
| Washington | 209,297 | 80,758 | 663,694 | 223,328 | 290,823 |
| Wyoming | 889,228 | 1,023,189 | 3,565,629 | 2,530,531 | 106,177 |
| Eastern States | | | | | ..... |
| Southern States | 13,599,047 | 13,855,612 | 15,211,086 | 15,134,960 | ..... |
| Middle States | | | | | ..... |
| Eastern States and unapportioned | ..... | ..... | ..... | ..... | 18,535,995 |
| Lead desilverizers and unapportioned. | [a] 500,000 | [a] 500,000 | [a] 100,000 | ..... | ..... |
| Total | 659,508,644 | 698,044,517 | 812,537,267 | 888,784,267 | 917,805,682 |

| State. | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|
| Alaska | 7,034,763 | 4,438,836 | 4,057,142 | 4,311,026 | 22,314,889 |
| Arizona | 256,778,437 | 289,523,267 | 291,110,298 | 297,250,538 | 303,202,532 |
| California | 33,696,602 | 39,643,835 | 53,568,708 | 45,760,200 | 35,835,651 |
| Colorado | 13,998,496 | 13,943,878 | 11,485,631 | 9,307,497 | 9,791,861 |
| Idaho | 9,707,299 | 7,256,086 | 7,096,132 | 6,877,515 | 4,514,116 |
| Michigan | 219,131,503 | 222,289,584 | 227,005,923 | 221,462,984 | 218,185,236 |
| Montana | 224,263,789 | 252,503,651 | 314,858,291 | 283,078,473 | 271,814,491 |
| New Mexico | 10,140,140 | 4,991,351 | 5,031,136 | 3,784,609 | 2,860,400 |
| Nevada | 1,998,164 | 12,241,372 | 53,849,281 | 64,494,640 | 65,561,015 |
| Oregon | 518,694 | 271,191 | 245,403 | 22,022 | 125,943 |
| South Dakota | ..... | 5,471 | 41,988 | 43 | 1,607 |
| Utah | 66,418,370 | 71,370,370 | 101,241,114 | 125,185,455 | 142,340,215 |
| Washington | 122,263 | 162,201 | 120,611 | 65,021 | 195,503 |
| Wyoming | 3,026,004 | 2,416,197 | 433,672 | 217,127 | 130,499 |
| Eastern States and unapportioned | 22,161,967 | 21,513,431 | 22,806,294 | 18,342,359 | 20,358,791 |
| Total | 868,996,491 | 942,570,721 | 1,092,951,624 | 1,080,159,509 | 1,097,232,749 |

[a] Based partly on estimates.

*Total production of copper by States, 1845–1911, and percentage and rank of each State.*

| State. | Quantity. | Percentage. | Rank. |
|---|---|---|---|
| Alaska | 59,126,344 | 0.36 | 10 |
| Arizona | 3,494,333,111 | 21.38 | 3 |
| California | 486,970,608 | 2.93 | 5 |
| Colorado | 213,543,924 | 1.30 | 7 |
| Idaho | 59,071,800 | .36 | 11 |
| Michigan | 4,974,605,378 | 30.35 | 2 |
| Montana | 5,598,253,884 | 34.16 | 1 |
| New Mexico | 95,183,563 | .58 | 9 |
| Nevada | 203,500,112 | 1.24 | 8 |
| Oregon | 2,575,727 | .02 | 14 |
| South Dakota | 5,255,420 | .03 | 13 |
| Utah | 797,044,788 | 4.89 | 4 |
| Washington | 2,173,284 | .01 | 15 |
| Wyoming | 25,973,899 | .16 | 12 |
| Eastern States and unapportioned | 364,988,674 | 2.23 | 6 |
| Total | 16,376,600,516 | 100.00 | ..... |

The totals in the preceding table show the copper output of each important copper-producing State, except those on the Atlantic coast since the beginning of the industry. Some copper was produced in New Mexico in the early years of the last century, but the exact quantity is not known. It was not large as measured by present production of the metal. A little copper was also produced in Michigan prior to 1845, but it was not sufficient in quantity to be of importance. Considerable copper was produced in the Eastern States prior to 1845.

Under "Eastern States and unapportioned" is included some copper classed as "lead desilverizers, etc.," in the earlier reports of the Survey. This should properly be credited to some of the Western States. The output of the Central States, except Michigan, is also included under this head. Statistics for the individual Eastern States have not been compiled, but it may be stated that approximately 230,600,000 pounds has been derived from Tennessee. Of the remainder, Vermont and Virginia have made the largest contributions, and some copper has been produced by practically all of the Appalachian States.

It will be noted that Montana, Michigan, and Arizona stand out as the three great copper-producing States. Montana ranks first, with more than one-third of the entire output of the country; Michigan ranks second, with slightly less than one-third; and Arizona ranks third, with over one-fifth of the total output. Utah, ranking next in order, has produced less than one-twentieth of the total output. The three leading States have produced 85.89 per cent of the entire production.

It will be noted by reference to the table showing the output for 1911 that these three States still maintain their preeminence, producing 81 per cent of the total output in 1908, 76 per cent in 1909, 74 per cent in 1910, and 72 per cent in 1911. The relative importance of other States, however, is much greater in recent years, Utah producing 11.6 per cent of the total 1911 output. The six leading States in 1911—Arizona, Montana, Michigan, Utah, Nevada, and California—produced 94.4 per cent of the output for that year. The same States have produced 95 per cent of the total output since 1845.

In the following table is given the blister copper output of the leading districts of the country in 1911:

*Blister copper production of principal districts in 1911, in pounds.*

| District or region. | State. | Approximate smelter output. | Percentage of total production. | Rank. |
|---|---|---|---|---|
| Butte | Montana | 271,200,000 | 24.72 | 1 |
| Lake Superior | Michigan | 218,180,000 | 19.89 | 2 |
| Bisbee | Arizona | 130,200,000 | 11.87 | 3 |
| Bingham | Utah | 125,500,000 | 11.44 | 4 |
| Morenci-Metcalf | Arizona | 71,590,000 | 6.52 | 5 |
| Ely | Nevada | 64,900,000 | 5.92 | 6 |
| Globe | Arizona | 44,600,000 | 4.07 | 7 |
| Jerome | do | 33,200,000 | 3.03 | 8 |
| Shasta County | California | 29,900,000 | 2.72 | 9 |
| Alaska (all districts) | | 22,300,000 | 2.03 | 10 |
| Ducktown | Tennessee | 18,960,000 | 1.73 | 11 |
| Mineral Creek (Ray) | Arizona | 15,700,000 | 1.43 | 12 |
| Tintic | Utah | 10,900,000 | .99 | 13 |
| Calaveras County | California | 5,500,000 | .50 | 14 |
| Leadville | Colorado | 4,000,000 | .36 | 15 |
| Frisco | Utah | 3,600,000 | .33 | 16 |
| Courtland | Arizona | 3,300,000 | .31 | 17 |
| Coeur d'Alene | Idaho | 2,900,000 | .26 | 18 |
| Big Bug | Arizona | 2,700,000 | .25 | 19 |
| Lordsburg | New Mexico | 2,400,000 | .22 | 20 |
| San Juan-Ouray region | Colorado | 2,000,000 | .18 | 21 |
| Alder Creek | Idaho | 1,600,000 | .14 | 22 |
| Santa Rita | New Mexico | 1,400,000 | .13 | 23 |
| Total | | 1,086,440,000 | 99.04 | |
| All others | | 10,560,000 | .96 | |
| Grand total | | 1,097,000,000 | 100.00 | |

As shown in this table, 21 districts in 1911, the same number as in 1910, each produced 2,000,000 or more pounds of blister copper. The 21 districts in 1911 produced more than 98.7 per cent of the copper output of the country; the 21 districts in 1910 produced 98 per cent of the total. In 1911 the 10 leading districts, only one of which yielded less than 20,000,000 pounds, produced nearly 92 per cent of the total output, as compared with 94 per cent in 1910 for the 10 leading districts.

The following table shows the output of the principal copper-producing districts of the United States from the beginning of production to the close of 1911. For the later years the statistics are compiled from reports furnished to the United States Geological Survey by the producing companies. For the earlier years the figures are taken mainly from reports on the several districts by members of the Survey.

*Total blister copper production of principal districts to the close of 1911, in pounds, and percentage of total and rank of each.*

| District. | State. | Production began. | Pounds. | Percentage of total production. | Rank. |
|---|---|---|---|---|---|
| Butte | Montana | 1868 | 5,586,200,000 | 34.08 | 1 |
| Lake Superior | Michigan | 1845 | 4,974,600,000 | 30.35 | 2 |
| Bisbee | Arizona | 1880 | 1,415,200,000 | 8.64 | 3 |
| Morenci-Metcalf | do | 1873 | 954,200,000 | 5.82 | 4 |
| Jerome | do | 1883 | 603,200,000 | 3.68 | 5 |
| Bingham | Utah | 1896 | 590,500,000 | 3.60 | 6 |
| Globe | Arizona | 1881 | 379,300,000 | 2.31 | 7 |
| Shasta County | California | 1897 | 365,900,000 | 2.23 | 8 |
| Ducktown | Tennessee | 1850 | 230,660,000 | 1.41 | 9 |
| Ely | Nevada | 1908 | 189,900,000 | 1.16 | 10 |
| Foothill belt | California | 1862 | 109,500,000 | .67 | 11 |
| Santa Rita | New Mexico | 1800(?) | 104,400,000 | .64 | 12 |
| All others | | | 873,017,000 | 5.41 | |
| Total | | | 16,376,600,000 | 100.00 | |

Twelve districts situated in eight States have each contributed in excess of 100,000,000 pounds to the copper output of the country. Four of these districts are in Arizona, 2 in California, and 1 each in Montana, Michigan, Nevada, New Mexico, Tennessee, and Utah. Two districts stand out prominently. They are the Butte district, Montana, which has contributed slightly over one third of the output of the country, and the Lake Superior district, Michigan, with a production of a little less than one-third of the total output. Bisbee, ranking third, has yielded 8.6 per cent of the total production. The 12 districts have yielded 94.59 per cent of the total output of the United States since 1845.

It will be seen by a comparison of the table showing the total output of the leading districts with the table showing the output of the leading districts in 1911 that the first 9 are the same, but that the order is changed to some extent.

It is noteworthy that there is not a single instance where one of the leading copper districts of the United States, several of which have been active producers for a period of 30 years or more, has been worked out or showed a decrease in its ability to produce copper.

## TONNAGE AND YIELD OF COPPER ORES.

### COPPER-BEARING ORES PRODUCED IN 1911.

The following tables show the tonnage and the yield in copper of the ores produced by the mines of the United States in 1911. The figures are taken from the mine reports of the various States, which form a part of the volume on Mineral Resources issued annually by the United States Geological Survey. As stated in a preceding paragraph, the close agreement between the output as reported by the mines and the actual recovery of metal by the smelters, when accumulated stocks are considered, leads to the belief that the tenor of ores as reported by the mines is very close to the actual recovery of metal. The classification of some of the complex western ores is a difficult and more or less arbitrary matter. Under copper ores are classed those which contain 2½ per cent or more of copper, as well as those which contain less than this percentage, provided their principal value is in copper. Under copper-lead and copper-zinc ores are classed complex ores in which copper is an important constituent. Considerable copper was reported by the mines from ores mined primarily for other metals, including siliceous gold and silver ores, lead ores, zinc ores, pyritic sulphur ores, and ores concentrated for values in other metals. No attempt has been made to compile tables showing the tonnage and yield of this group of copper-bearing ores, but together with old slags, etc., they have yielded a total of 19,633,093 pounds of copper.

*Copper produced in 1911 from ores in which copper constitutes the principal value, by States.*

| State. | Copper ore. | Copper in ore. | Percentage. | Gold in ore. | Silver in ore. | Value in gold and silver per ton. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Pounds.* | | *Fine ounces.* | *Fine ounces.* | |
| Alaska | 68,975 | 27,267,878 | 19.77 | 4,187.77 | 320,114 | $3.71 |
| Arizona | 4,274,209 | 305,110,593 | 3.57 | 51,377.93 | 2,136,121 | .51 |
| California | 494,281 | 36,316,136 | 3.67 | 20,694.28 | 864,397 | 1.79 |
| Colorado | 18,221 | 1,652,247 | 4.53 | 8,472.08 | 342,550 | 19.58 |
| Idaho | 40,061 | 3,975,384 | 4.96 | 4,492.30 | 254,095 | 5.47 |
| Michigan | 10,978,827 | 219,840,201 | 1.00 | ..... | 497,281 | .02 |
| Montana | 4,332,479 | 271,079,252 | 3.13 | 31,300.27 | 9,597,752 | 1.32 |
| Nevada | 2,778,325 | 67,286,120 | 1.22 | 21,841.27 | 111,474 | .18 |
| New Mexico | 69,305 | 3,240,693 | 2.33 | 2,920.69 | 108,892 | 1.70 |
| Oregon | 4,205 | 93,136 | 1.11 | 420.48 | 9,953 | 3.32 |
| Pennsylvania and Maryland | 219,868 | 665,110 | .15 | .44 | 87 | .0002 |
| Tennessee | 581,974 | 18,850,276 | 1.62 | 562.17 | 106,660 | .117 |
| Utah | 6,121,099 | 139,382,161 | 1.19 | 117,247.94 | 2,377,946 | .60 |
| Washington | 4,362 | 253,333 | 2.95 | 117.53 | 31,899 | 4.43 |
| Wyoming | 2,044 | 118,584 | 2.90 | 12.43 | 417 | .23 |
| Total and average | 29,988,235 | 1,095,131,104 | 1.825 | 263,647.58 | 16,759,638 | .492 |

*Copper ores concentrated and smelted, concentrates produced, and copper produced from each class of ore in 1911, by States.*

| State. | Ore concentrated. | | | | Ore smelted. | | |
|---|---|---|---|---|---|---|---|
| | Quantity. | Concentrates produced. | Copper in concentrates. | Percentage of copper from ore. | Quantity. | Copper produced. | Percentage of copper from ore. |
| | *Short tons.* | *Short tons.* | *Pounds.* | | *Short tons.* | *Pounds.* | |
| Alaska | ..... | ..... | ..... | ..... | 68,975 | 27,267,878 | 19.77 |
| Arizona | 2,618,220 | 304,123 | 69,630,441 | 1.84 | 1,655,989 | 208,780,152 | 6.30 |
| California | ..... | ..... | ..... | ..... | 494,281 | 36,316,136 | 3.67 |
| Colorado | ..... | ..... | ..... | ..... | 18,221 | 1,652,247 | 4.53 |
| Idaho | ..... | ..... | ..... | ..... | 40,061 | 3,975,384 | 4.96 |
| Michigan | 10,978,827 | 169,454 | 219,840,201 | 1.00 | ..... | ..... | ..... |
| Montana | 3,706,435 | 1,255,572 | 198,314,017 | 2.56 | 566,044 | 72,765,235 | 6.43 |
| Nevada | 2,745,536 | 242,000 | 65,266,122 | 1.19 | 32,789 | 2,019,998 | 3.08 |
| New Mexico | 43,089 | 2,725 | 1,057,977 | 1.23 | 26,216 | 2,182,716 | 4.16 |
| Oregon | ..... | ..... | ..... | ..... | 4,205 | 93,136 | 1.11 |
| Pennsylvania | } ..... | ..... | ..... | ..... | 219,868 | 665,110 | .15 |
| Maryland | | | | | | | |
| Tennessee | ..... | ..... | ..... | ..... | 581,974 | 18,850,276 | 1.62 |
| Utah | 5,480,370 | 220,583 | 106,744,211 | .97 | 640,729 | 32,637,950 | 2.55 |
| Washington | 108 | 36 | 7,937 | 3.67 | 4,254 | 245,396 | 2.75 |
| Wyoming | ..... | ..... | ..... | ..... | 2,044 | 118,584 | 2.90 |
| Total and average. | 25,632,585 | 2,202,590 | 687,560,906 | 1.34 | 4,355,650 | 407,570,198 | 4.66 |

*Copper produced from copper-lead and copper-zinc ores in 1911, by States.*

| State. | Copper-lead and copper-zinc ores. | Copper in ore. | Percentage of copper. |
|---|---|---|---|
| | *Short tons.* | *Pounds.* | |
| Arizona | 129 | 10,603 | 4.11 |
| Colorado | 1,398 | 93,025 | 3.32 |
| Montana | 1,177 | 104,220 | 4.47 |
| Nevada | 216 | 23,644 | 10.14 |
| New Mexico | 450 | 36,328 | 4.03 |
| Utah | 3,553 | 317,359 | 4.46 |
| Total and average | 6,923 | 585,179 | 4.22 |

*Copper derived from ore classed as copper-bearing ores (copper, copper-lead, and copper-zinc ores), and total production of copper from all sources in 1911, by States.*

| State. | Ore treated. | Copper recovered. | Percentage of copper. | Copper from all sources, including old slags, smelter cleanings, precipitates, etc. |
|---|---|---|---|---|
| | *Short tons.* | *Pounds.* | | *Pounds.* |
| Alaska | 68,975 | 27,267,878 | 19.77 | 27,267,878 |
| Arizona | 4,274,338 | 305,121,196 | 3.56 | [a] 306,141,538 |
| California | 494,281 | 36,316,136 | 3.67 | 36,316,136 |
| Colorado | 19,619 | 1,745,272 | 4.44 | [b] 8,024,488 |
| Idaho | 40,061 | 3,975,384 | 4.96 | [c] 5,152,937 |
| Michigan | 10,978,827 | 219,840,201 | 1.00 | 219,840,201 |
| Missouri | | | | [d] 640,411 |
| Montana | 4,333,656 | 271,183,472 | 3.13 | 272,847,705 |
| Nevada | 2,778,325 | 67,309,764 | 1.22 | [e] 67,377,518 |
| New Mexico | 69,755 | 3,277,337 | 2.45 | [f] 4,057,040 |
| Oregon | 4,205 | 93,136 | 1.11 | 93,136 |
| Pennsylvania and Maryland | 219,868 | 665,110 | .15 | 665,110 |
| Philippine Islands | | | | 2,205 |
| Tennessee | 581,974 | 18,850,276 | 1.62 | 18,850,276 |
| Utah | 6,124,652 | 139,699,520 | 1.14 | [g] 146,960,827 |
| Virginia and New York | | | | [h] 90,000 |
| Washington | 4,362 | 253,333 | 2.95 | 318,207 |
| Wyoming | 2,044 | 118,584 | 2.90 | 118,584 |
| Total and average | 29,994,942 | 1,095,716,597 | 1.826 | 1,114,764,197 |

[a] Some copper was produced from siliceous and lead ores.
[b] Most of the copper from Colorado is derived from ores classed as siliceous ores and lead ores.
[c] Considerable copper is produced from ores classed as lead ores.
[d] By-product of lead ores.
[e] Considerable copper was produced from zinc and siliceous ores.
[f] Considerable copper was produced from siliceous ores.
[g] Considerable copper was recovered from ores classed as siliceous ores and lead ores.
[h] From mine water.

*Copper ores produced in the United States, 1906–1911, by years, in short tons, and average yield in copper, gold, and silver.*

| Year. | Copper ores. | Yield in copper. | Yield per ton in gold. | Yield per ton in silver. | Value per ton in gold and silver. |
|---|---|---|---|---|---|
| | *Short tons.* | *Per cent.* | *Ounces.* | *Ounces.* | |
| 1906 | 18,000,000 | 2.50 | 0.0150 | 0.882 | $0.856 |
| 1907 | 20,253,000 | 2.11 | .0135 | .609 | .682 |
| 1908 | 22,290,886 | 2.07 | .0104 | .666 | .560 |
| 1909 | 27,932,618 | 1.98 | .0097 | .655 | .540 |
| 1910 | 28,497,238 | 1.88 | .0093 | .562 | .495 |
| 1911 | 29,988,235 | 1.82 | .0089 | .555 | .492 |

*Copper ores produced in the United States, 1906–1911, by years, classified as smelting and concentrating ores, in short tons, and average yield in copper from each.*

| Year. | Smelting ores. | | Concentrating ores. | |
|---|---|---|---|---|
| | Quantity. | Yield in copper. | Quantity. | Yield in copper. |
| | *Short tons.* | *Per cent.* | *Short tons.* | *Per cent.* |
| 1906 | 3,278,000 | | 14,722,000 | |
| 1907 | 3,957,500 | 4.05 | 16,295,500 | 1.41 |
| 1908 | 4,665,534 | 4.27 | 17,760,522 | 1.485 |
| 1909 | 5,267,707 | 4.15 | 22,664,911 | 1.47 |
| 1910 | 5,001,394 | 4.14 | 23,495,844 | 1.40 |
| 1911 | 4,355,650 | 4.66 | 25,632,585 | 1.34 |

### TONNAGE.

The output of copper, copper-lead, and copper-zinc ores mined in 1911 was 29,994,942 tons, as compared with 28,517,556 tons in 1910. Of this output 29,988,235 tons were copper ores and 6,923 tons were copper-lead and copper-zinc ores, as compared with 28,497,238 tons of copper ores and 20,318 tons of copper-lead and copper-zinc ores in 1910. Of the 29,988,235 tons of copper ores, 4,355,650 tons were smelting ores and 25,632,585 tons were concentrating ores, as compared with 5,001,394 tons of smelting ores and 23,495,884 tons of concentrating ores in 1910.

In 1911 concentrating ores produced 2,202,590 tons of concentrates, the average concentration being 11.6 into 1, as compared with 11.3 into 1 in 1910 and with 9.7 into 1 in 1909. Excluding the ores and concentrates from Michigan, 14,653,758 tons of ore produced 2,033,136 tons of concentrates, or a concentration of about 7.2 into 1, as compared with 6.7 into 1 for 1910.

It is seen by reference to the tables showing the production of ores for the last five years that there has been an increase of over 66 per cent in the tonnage mined since 1906. The actual increase has been most in concentrating ores. The output of smelting ores has increased about 33 per cent and that of concentrating ores has increased about 74 per cent. Michigan, with 10,978,827 tons, was by far the largest producer of copper ores in 1911, and was followed in order by Utah, Montana, Arizona, Nevada, Tennessee, and California. In the output of smelting ores the States were in the following order: Arizona, Utah, Tennessee, Montana, and California; in the output of concentrating ores Michigan was first, followed in order by Utah, Montana, Nevada, and Arizona.

### YIELD.

The 29,994,942 tons of copper, copper-lead, and copper-zinc ores mined in 1911 contained 1,095,716,597 pounds of recoverable copper, or an average of 1.826 per cent, as compared with 1.88 per cent for 1910 and with 1.98 per cent for 1909. If the Michigan output is excluded, the yield of the remaining copper ores was 2.30 per cent in 1911, as compared with 2.41 per cent in 1910 and with 2.63 per cent in 1909.

In 1911 copper ores produced 1,095,131,104 pounds of copper, or an average yield of 1.825 per cent copper, and copper-lead and copper-zinc ores produced 585,179 pounds, or an average yield of 4.22 per cent copper. The 4,355,650 tons of smelting ore yielded 407,570,198 pounds of copper, or an average of 4.66 per cent, as compared with 4.14 per cent for 1910 and with 4.15 per cent for 1909.

The 25,632,585 tons of concentrating ore yielded 687,560,906 pounds, or an average of 1.34 per cent, as compared with 1.40 per cent for 1910 and with 1.47 per cent for 1909. Excluding the ores from Michigan, which yielded an average of 1 per cent in 1911, the concentrating ores from the remainder of the United States yielded an average of 1.59 per cent, as compared with 1.73 per cent in 1910 and with 1.92 per cent in 1909.

As shown in the table giving yield in copper, gold, and silver, there has been a marked decrease in the tenor of copper ores treated during the last six years, the average yield dropping from 2.50 per cent in

1906 to 1.82 per cent in 1911. The average yield of the smelting and the concentrating ores, considered separately, shows less change, the decrease in the average of total ores being due to an increase in the tonnage of concentrating ores.

Alaska produced the highest grade of ore in 1911, the average yield being 19.77 per cent copper; California was second, with 3.67 per cent; Arizona was third, with 3.57 per cent; Montana was fourth, with 3.13 per cent; and Tennessee, Nevada, and Utah followed in the order named.

Of the States producing an important amount of smelting ore Alaska had the highest yield with 19.77 per ton, followed by Montana with 6.43 per cent, Arizona with 6.30 per cent, California with 3.67 per cent, and Utah and Tennessee with 2.55 and 1.62 per cent, respectively.

In the yield from concentrating ores Montana took first rank with an average of 2.56 per cent, followed by Arizona, with 1.84 per cent; Nevada, 1.19 per cent; Michigan, 1 per cent; and Utah, 0.97 per cent.

In 1911 copper ores yielded 263,647.57 ounces of gold and 16,759,638 ounces of silver, or an average of 0.0089 ounce of gold and 0.555 ounce of silver per ton. The total value of the gold and silver content of copper ores was $14,332,203, an average precious-metal value of 49.2 cents per ton. In 1910 copper ores yielded 0.0093 ounce of gold and 0.562 ounce of silver per ton, an average precious-metal value of 49.5 cents per ton. Exclusive of that portion of the Michigan ores from which the silver was not recovered, the average precious-metal content was 67 cents per ton of ore, as compared with 73.8 cents in 1910 and with 83.4 cents in 1909.

Exclusive of the Michigan ores that did not yield silver, there was still included considerable ore from which the gold and silver values were not recovered, namely, that producing the casting copper from the Morenci-Metcalf district, Arizona, and from the Ducktown district, Tennessee, and to a slight extent from other districts. This casting copper was not electrolytically refined, and consequently the precious-metal values were not recovered from it.

Among the important copper-producing States Alaska was first in the yield in gold and silver per ton of copper ore, the average being $3.71; California was second, with $1.79 per ton; Montana third, with $1.32 per ton; Utah, with $0.60; Arizona, $0.51; Nevada, $0.18; Tennessee, $0.117; and Michigan, $0.02.

## REVIEW BY STATES.

### INTRODUCTORY STATEMENT.

In the following pages a brief statement of the conditions affecting production in the principal districts of the country is presented, the geologic occurrence of the ores is briefly summarized, and the tenor of ore from each district is given when this will not disclose the production of individual companies, the figures of whose output have not already been published in their annual report or elsewhere.

Those desiring more detailed information of the mining operations of the districts are referred to the reports on mine production for the various States, which have heretofore been published by the United States Geological Survey and which, with this and other

reports, form the first part of the present volume Mineral Resources of the United States for 1911.

The report for 1910 contained a map showing the location of the principal copper-producing districts of the United States and the location of the principal reduction plants. The map has not been reproduced in this report, but copies of the 1910 report can be obtained on application to the Director of the United States Geological Survey.

## ALASKA.

The blister copper production from Alaska in 1911 was 22,314,889 pounds, as compared with 4,311,026 pounds in 1910. The large increase in the output for 1911 is due to the entrance of the Copper River district into the producing list. The mine production of copper for 1911 was 27,267,878 pounds, but a considerable portion of this had not been smelted at the close of the year.

Important productions of copper from Alaska began about 1903, since which time it has been a steady contributor of that metal. To the close of 1911 the total production of blister copper has been 59,126,334 pounds. The output for 1911 was from the Ketchikan, Prince William Sound, and Copper River districts, the last making its first output during the year and being by far the most important producer.

*Ketchikan district.*—The Ketchikan district made the smallest output in several years, producing scarcely 1,000,000 pounds as compared with about 2,000,000 pounds for 1910. The deposits of the district [1] thus far developed are of contact origin, the ores run high in iron, being composed of pyrrhotite, magnetite, pyrite, and chalcopyrite, and are a desirable ore for the British Columbia and Washington smelters. Neither of the smelting plants in the district was in operation during 1911, the ores being shipped to the Ladysmith and the Tacoma smelters. Only the relatively high-grade ores are shipped, as the low-grade material can not be marketed profitably at the present price of copper. The average yield in copper is between 4 and 5 per cent, and the ores carry rather low values in gold and silver.

*Prince William Sound district.*—In 1911 the Prince William Sound district more than doubled the production for 1910. The ores of the district were shipped to the Tacoma smelter. The deposits [2] consist of pyrrhotite, chalcopyrite, and pyrite, with minor amounts of other sulphides occurring in shear zones in or closely associated with greenstone. The largest producer was the Beatson Bonanza mine, though the Ellamar mine was an important producer and others also contributed. Other copper properties were being developed.

*Copper River district.*—Production of copper from the Copper River district began in 1911, the first shipment of ore being made April 6. The Bonanza mine was the only producer during the year, though other properties were being developed and in some cases encouraging results are reported.

---

[1] For detailed descriptions see Wright, C. W., and Paige, S., Mineral resources of Alaska in 1907: Bull. U. S. Geol. Survey No. 345, 1908, pp. 98–115; and Wright, F. E., and Wright, C. W., Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908.

[2] Grant, U. S., and Higgins, D. F., Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska: Bull. U. S. Geol. Survey No. 443, 1910, pp. 87–96.

The primary ores[1] of the Bonanza mine are principally chalcocite with some bornite, replacing limestone near a greenstone contact. These minerals have been partly altered to carbonates at the surface. This is one of the few important copper deposits known in which chalcocite, the principal ore mineral, is regarded as a primary mineral. Much of the ore is almost pure chalcocite and is very high grade. Only the high-grade ore was shipped during the year, but a mill was constructed for concentrating the lower-grade material in the talus.

### ARIZONA.

In 1911 Arizona produced 303,202,532 pounds of blister copper, as compared with 297,250,538 pounds in 1910. This is the largest output in the history of the State and continues Arizona in first place among the copper-producing States.

The steady output of copper from Arizona began about 1875, though there was intermittent production prior to that date, the earliest record of production being for 1862. Since 1880 the growth of the industry has been steady and rapid. To the close of 1911 Arizona had a recorded production of 3,494,333,111 pounds of copper, or 21.38 per cent of the total output of the country, thus giving the State third rank among the copper-producing States. Arizona produced 27.63 per cent of the total output of the country for 1911.

Nine copper-smelting plants operated within the State during the year.

The greater part of the production was from five districts.

*Bisbee district.*—The Bisbee or Warren district, in southern Cochise County, was the largest producer, with about 130,200,000 pounds of blister copper, as compared with 142,500,000 pounds in 1910. Production in the district began in 1880, since which time it has been a constant and increasingly important contributor to the output of copper. To the close of 1911 it had produced 1,415,200,000 pounds of copper, or 8.64 per cent of the output of the country and 40.3 per cent of the Arizona production. In total and in present output it ranks third among the copper districts of the country.

The Paleozoic sediments[2] of the district have been faulted and fissured, and granite porphyry has been intruded in the form of stocks, dikes, and sills. The Sacramento Hill stock is the most prominent body of granite prophyry in the district, but in the mine workings dikes and sills of the porphyry are found extending into the limestones, and in the southern part of the district the porphyry masses are possibly not directly connected with the Sacramento Hill mass, though both were doubtless derived from the same source. The ores occur replacing the limestone closely associated with the granite porphyry bodies, and also replacing the limestone along faults and fissures. So close is the association of ore and porphyry that in recent years prospecting has been guided to a considerable extent by this association. The presence of amphibole, pyroxene, garnet,

[1] Moffit, F. H., and Maddren, A. G., Mineral resources of Kotsina-Chitina region, Alaska: Bull. U. S. Geol. Survey No. 374, 1909.

[2] For detailed geologic report, see Ransome, F. L., Geology and ore deposits of the Bisbee quadrangle, Arizona: Prof. Paper U. S. Geol. Survey No. 21, 1904; Rice, Claude T., Camp of Bisbee, Arizona: Mines and Methods, Salt Lake City, Utah, vol. 1, 1909, p. 241; Weed, W. H., Is geology a success as a guide to ore deposits: Min. and Eng. World, vol. 27, p. 245.

vesuvianite, etc., associated with the ore minerals indicates a contact metamorphic origin of the ore bodies.

The primary ores are largely cupriferous pyrite, or a mixture of pyrite and chalcopyrite, carrying low values in copper. The workable ore bodies thus far developed have resulted from the concentration of the copper contained in the primary ores by the process known as "secondary enrichment." Under favorable conditions these secondary changes have extended to great depth. In the upper workings the copper is principally in the form of carbonate oxides and native copper. With increasing depth, sulphide ores become relatively more important. The richer ores of the latter class have resulted from the partial replacement of the original ores by the richer secondary copper sulphides. Under favorable conditions this enrichment has taken place to the greatest depth attained in mining developments.

In the early days the output of copper was entirely from oxidized ores, but in recent years the quantity derived from sulphide ores has rapidly increased and at the present time probably equals that derived from oxidized ores.

It is reported by the companies that additions of ore reserves in all the properties have fully equaled or exceeded extraction and in some cases important developments have been made. In the Oliver shaft new oxide ore bodies were found on the 1,050-foot and 1,250-foot levels and new sulphide bodies on the 1,250-foot and 1,600-foot levels. Large bodies of iron pyrite assaying from 2 to 4 per cent copper have been developed in the Briggs shaft, together with smaller bodies of higher grade ore. An especially interesting development in the Copper Queen mine was the discovery, in the Spray division of the mine, of sulphide ore in the Abrigo limestone of Cambrian age. Previously ore had not been developed at so low a geological horizon. Another discovery that may prove of importance is the occurrence of disseminated chalcocite ores in the porphyry of Sacramento Mountain. The Shattuck-Arizona Co. also reports the development of important ore bodies.

The nature of the deposits of the district do not favor the blocking out of extensive ore reserves far in advance of immediate needs, since the cost of keeping the heavy ground open for a long period is prohibitive. The quantity of ore actually blocked out in proportion to the annual output of copper is probably as small for this district as for any large producing district in the country.

Most of the ore occurs in irregular bodies without definite arrangement, so that the cost of prospecting is greater than in many other districts. Moreover, the soft heavy ground associated with the ore makes it necessary to employ the square set method in mining, and the cost of timber adds materially to the cost of mining. Recently efforts have been made by both of the principal companies to modify their system of mining so as to use less timber. The cost of mining in the district, however, is likely to remain relatively high. Centralization and improvement in the hauling and hoisting systems of the mines has resulted in marked economy. The ores of the district continue to show a decrease in grade, but this is in part due to improvement in mining and metallurgical methods which permit the treatment of lower grade material. It is the policy of most of the companies to mine as low-grade ore as can be treated at a reasonable

profit. In the early days of mining in the district the oxidized ores yielded about 20 per cent of copper. For 1911 the average recovery was about 5.9 per cent copper, with 0.0308 ounce gold and 1.49 ounces silver per ton, an average precious metal value of $1.42 per ton of ore.

The Copper Queen mine produced a total of 619,132 tons of ore and precipitate, containing 74,489,728 pounds of copper, 16,895 ounces of gold, and 1,227,453 ounces of silver.

The Calumet & Arizona Mining Co. produced 21,476,739 pounds of copper, 216,987 ounces of silver, and 9,329 ounces of gold. The average net cost per pound of refined copper produced was 8.33 cents.

The following table shows the grade of ores:

*Operations of the Calumet & Arizona Mining Co. in 1911.*

| | Wet. | Dry. |
|---|---|---|
| Tons ore mined (including fluxing ore) | 265,831 | 244,067 |
| Tons ore shipped (including fluxing ore) | 266,607 | 244,772 |
| Tons ore smelted (not including fluxing ore) | 231,135 | 212,370 |
| Tons fluxing ore smelted | 42,474 | 38,831 |
| Pounds copper recovered per ton ore | 89,747 | 97.677 |
| Pounds copper recovered per ton fluxing ore | 12.250 | 13.400 |
| Per cent copper recovered per ton ore | 4.487 | 4.884 |

The Superior & Pittsburg Mining Co. produced 28,469,166 pounds of copper, 236,960 ounces of silver, and 8,785 ounces of gold. The net cost per pound of refined copper produced was 6.60 cents. The grade of the ore is shown in the following table:

*Operations of the Superior & Pittsburg Mining Co. in 1911.*

| | Wet. | Dry. |
|---|---|---|
| Tons of ore mined | 229,903 | 205,603 |
| Tons of ore shipped | 229,985 | 205,675 |
| Tons of ore smelted | 230,620 | 206,234 |
| Pounds of copper recovered per ton | 123.719 | 138.348 |
| Per cent of copper recovered | 6.1859 | 6.9174 |

From August 1, 1910, to June 9, 1911, the Shattuck-Arizona Mining Co. shipped 32,029 tons of ore averaging 12.85 per cent copper. Shipments were discontinued on June 9.

At Douglas the smelting plants of the Copper Queen Consolidated Mining Co. and the Calumet & Arizona Mining Co. were operated throughout the year. The Copper Queen Consolidated Mining Co. had in process the construction of an addition to the smelter to consist of a calcining and reverberatory plant to treat fine ores, concentrates, and flue dust. It will consist of two reverberatory furnaces and six calciners of the McDougal type, with the necessary bins to store concentrates, dust-chamber flues, and stacks. These additions will be completed in 1912.

In 1911, in addition to Copper Queen ores, the smelter treated the ores and concentrates of the Montezuma Copper Co., of Mexico, and custom ores from Arizona and New Mexico.

The Calumet & Arizona Mining Co. completed plans for and began construction of a new smelting plant, which it is expected will be

ready for operation by August, 1913. The plans contemplate a complete custom sampling mill; Cananea bedding system (with capacity for 58,000 tons); two 48-inch by 40-foot blast furnaces; dust chamber 60 feet by 180 feet; steel stack lined with acid-proof tiling 350 feet by 25 feet in diameter; four 19-foot by 100-foot reverberatories, with foundation and building for fifth; twelve 21-foot Herreshoff roasting furnaces and suitable dust chamber; and six Great Falls converters 12 feet in diameter.

The district is served by the El Paso & Southwestern Railroad. Oil for fuel is used extensively in the production of power, which is generated in central plants and distributed to the points where needed.

Early in 1911 a merger of the Calumet & Arizona and Superior & Pittsburg Mining Cos. was effected. The stock of the Calumet & Arizona Mining Co. was increased to 650,000 shares and an exchange made for the stock of the Superior & Pittsburg Mining Co. on the basis of 1 share of Calumet & Arizona for 3½ shares of Superior & Pittsburg.

*Morenci-Metcalf district.*—The deposits of the Morenci-Metcalf district are at Morenci and Metcalf, in Greenlee County. During 1911 the district produced 71,500,000 pounds of blister copper, as compared with about 73,154,000 pounds in 1910.

The district was one of the earliest copper producers in the State, the output beginning as early as 1873, and since 1880 it has been an important contributor to the copper output of the country. To the close of 1911 a total of 954,200,000 pounds of copper had been produced, or 5.82 per cent of the output of the country since 1845, and 27.2 per cent of the output of the State. In total production it ranks fourth among the copper districts of the country and second in the State; in the output for 1911 it ranks fifth in the country and second in the State.

The copper ores [1] of this district occur as contact deposits in Paleozoic limestones and shales which have been intruded by stocks and dikes of porphyry, as disseminated deposits mainly in the porphyry, and as deposits in fault fissures of the Coronado type.

The original ores were pyrite and chalcopyrite of too low grade to be of economic importance. The workable bodies have resulted from the process of secondary enrichment. The ore bodies in the limestone were formed in certain beds favorable to deposition, and this produced roughly tabular bodies nearly parallel to the stratification of the limestone. Alteration of these bodies has produced oxidized ores which formed most of the workable ores in the limestone. These are now nearly exhausted.

The disseminated ores occur in highly altered porphyry adjacent to fissure veins. The copper content of the upper portion of these deposits has been leached and deposited as chalcocite on the pyrite lower down. This has produced a zone of commercial ore varying in thickness, in general not extending below a depth of 400 feet.

In the fault fissure or Coronado type of deposit commercial ore has been developed to much greater depth, and recent exploration of the principal faults in Copper Mountain has shown that commercial

[1] For detailed report of the Clifton-Morenci district see Lindgren, W., The copper deposits of the Clifton-Morenci district, Arizona: Prof. Paper U. S. Geol. Survey No. 43, 1905; Tovote, William L., Min. and Sci. Press, vol. 101, 1910, p. 770.

ore occurs associated with these faults considerably below the general level of the ore zone.

Of the 1911 copper output, 54,000,000 pounds were derived from concentrating ores and 17,500,000 pounds from smelting ores. The mines of the district produced 1,323,447 tons of concentrating ores, yielding 2.01 per cent copper, and 222,551 tons of smelting ore yielding an average of 4 per cent copper, the average yield for the 1,545,998 tons of ore produced in the district being 2.29 per cent.

The ores in general carry low gold and silver values, and as much of the copper is of sufficient purity for commercial purposes it is not refined electrolytically, and consequently the precious metal content is not recovered.

Until recently the square set and fill system of mining which necessitated the use of large amounts of timber was very generally employed in the district. More lately modified systems of slicing and caving have been introduced and are being extended, so that at present a large percentage of the ore is extracted by these methods at a considerably reduced cost.

The district contains large reserves of ores, and developments during 1911 have fully maintained the reserves and added to the possibilities of ore in both the Morenci and the Metcalf sections of the district.

The Detroit Copper Co reduced to bullion 517,087 tons of ore, yielding 22,704,398 pounds of copper, or an average of 45.9 pounds of copper per ton of ore treated. The following tables show the results of operations at the mill and smelter:

*Concentrator operations of Detroit Copper Co., Arizona, in 1911.*

| | | |
|---|---|---|
| Ore concentrated | tons. | 500,000 |
| Percentage of copper in ore | | 2.869 |
| Concentrates produced | tons. | 66,012.14 |
| Percentage of copper in concentrates | | 15.876 |
| Saving | | 73.05 |
| Tailings assay | | .848 |
| Tons ore milled per ton of concentrates | | 7.57 |
| Water used per ton ore milled | gallons. | 522.6 |

*Statement of ores completely reduced to bullion during the year, the original assay, and the yield of same, by the Detroit Copper Mining Co., in 1911.*

| | Ore treated to bullion. | Bullion produced. | Percentage of copper assay of original ore. | Percentage of yield in copper bullion per ton ore. |
|---|---|---|---|---|
| | *Short tons.* | *Pounds.* | | |
| Concentrating ore | 500,379 | 19,429,038 | 2.866 | 1.941 |
| Smelting ore | 6,678.3 | 2,083,680 | 16.846 | 15.598 |
| Siliceous ores to converters | 9,096 | 968,520 | 5.749 | 5.323 |
| Total Detroit Copper Mining Co. ores treated at Morenci | 516,153.3 | 22,481,238 | 3.098 | 2.179 |
| Purchased ores treated at Morenci | 933.5 | 223,160 | 12.909 | 11.953 |
| Grand total | 517,086.8 | 22,704,398 | 3.116 | 2.195 |

During the fiscal year ending September 30, 1911, the Arizona Copper Co. (Ltd.) produced 34,584,000 pounds of copper. The company's mines produced 744,746 dry tons. The average yield in copper per ton of ore treated was 46.4 pounds, or 2.32 per cent. This

compares with a yield of 2.13 per cent for the preceding year. Of the total ores, 94 per cent were concentrating ores and 6 per cent smelting ores. Of the total copper production, 82 per cent was derived from sulphide ores and 18 per cent from oxidized ores. During the latter part of the year plans were inaugurated for the construction of a new smelting plant to replace the present one, which has become out of date.

For the fiscal year ending August 31, 1911, the smelter of the Shannon Copper Co. produced 14,944,933 pounds of copper from company ores and 223,169 pounds from custom ores. During the same period the mines of the company yielded 263,975 tons of ore, with an average extraction of 56.9 pounds per ton. The average cost per pound of copper for the year was 11.5 cents.

The district is served by the line of the Arizona & New Mexico Railway Co. A narrow-gage line extends from Morenci to connect with the Arizona & New Mexico Railway at Coronado. Early in 1910 the Shannon Copper Co. completed a standard gage road connecting the mines at Metcalf with the concentrating and smelting works at Clifton.

*Jerome district.*—The Jerome or Verde district of Yavapai County produced about 33,200,000 pounds of blister copper in 1911, as compared with about 38,660,000 pounds in 1910. The production of copper in the district began about 1883, though it had yielded gold and silver previous to that time. Since 1888 it has been a steady and important producer.

To the close of 1911 it has yielded a total of 603,200,000 pounds of copper, or 3.68 per cent of the total output of the country since 1845, and 17.2 per cent of the total output of the State. In total output it stands fifth among the copper districts of the country and third in Arizona. In output for 1911 the district ranks eighth among those of the country and fourth in the State.

According to Graton [1] the ore body of the United Verde mine is an irregular lenticular mass, replacing a schistose rock that has resulted from the intense sheering of a rather basic porphyry. The ore minerals, mainly sulphides of iron, copper, and zinc, have partly or completely replaced the rock in some instances; in others, they occur as veins and stringers in the schist. The ores are of pre-Cambrian age.

The ores differ from most of the large copper deposits of Arizona in carrying rather high gold and silver values. The copper content of the ore is also unusually high for this type of deposit.

As little timber as possible is employed in mining on account of the danger from fire.

Considerable copper is recovered from the mine waters that have leached through the burning stopes by precipitation on scrap iron.

Most of the ore is smelted at the United Verde Copper Co.'s plant. The ore high in sulphur is roasted and smelted in blast furnaces. Some of the ore low in sulphur is smelted without roasting.

The United Verde Co. has under construction a new smelting plant to replace the one now in use.

According to published figures, the United Verde Copper Co., the only important producer of the district, made an output of 33,167,987

[1] Graton, L. C., Mineral Resources U. S. for 1907 pt. 1, 1908, p. 597.

pounds of copper, 461,145 ounces of silver, and 15,239 ounces of gold in 1911. The precious metal content was equivalent to about 1.6 cents per pound of copper.

Development was carried on by other companies in the district during the year, but no important production was made. The district is served by a narrow-gage railroad owned by the United Verde Copper Co., which connects with the Santa Fe, Prescott & Phoenix Railway.

*Globe district.*—The Globe district of Gila County produced about 44,600,000 pounds of blister copper in 1911, as compared with about 27,600,000 pounds in 1910. The increase in production was largely due to the beginning of production by the Miami Copper Co. The mine production for the year considerably exceeded the smelter production, as considerable material had not been smelted at the close of the year.

Production of copper began in the district about 1881; the camp was well known as a silver producer before that date. For several years subsequent to 1881 the production was intermittent, but since 1888, and especially since 1898, when the railroad reached the camp, the district has ranked among the important copper producers of the country. To the close of 1911 it has produced a total of 379,300,000 pounds of copper, or 2.31 per cent of the output of the country since 1845, and 10.8 per cent of the output of the State. In total production the district ranks seventh in the country and fourth in the State; for 1911 it ranks seventh in the country and third in the State. Important production began in the Miami section in 1911 and this section of the district will continue to grow in importance.

The geology [1] of the district may be briefly summarized as follows: Paleozoic sediments, consisting of conglomerates, quartzites, shales, and limestones were laid down unconformably on a pre-Cambrian basement of schist and intruded granitic rocks. In post-Paleozoic time the region was invaded by an intrusion of diabase followed by an intrusion of granitic rock. After a period of erosion the area was partly or wholly buried beneath Tertiary volcanic and sedimentary rocks which have since been partly removed by erosion.

The copper deposits are believed to have been introduced at the time of or closely following the post-Paleozoic granitic intrusion, and the source of the copper-bearing solutions is believed to have been connected with this igneous rock. The deposits of the district are of quite different types, dependent largely upon the nature of the rocks in which they were formed. In the Globe end of the district the deposits occur as roughly lenticular deposits replacing limestone, and as fault lodes or fissure zones of quartz and sulphide in diabase.

In the Miami end of the district the ores occur mainly as small veins of quartz and sulphide in the shattered rock near the granite schist contact, the mineralization occurring in both formations.

Most of the ores developed to the present time owe their commercial value to secondary enrichment. The ore extracted from the limestone has been largely oxidized, and much of the ore developed in

[1] For detailed description see Ransome, F. L., Geology of the Globe copper district, Arizona: Prof. Paper U. S. Geol. Survey No. 12, 1903; Ransome, F. L., Geology at Globe, Arizona: Min. and Sci. Press, vol. 100, 1910, p. 256; Ransome, F. L., Geology of the Globe district, Arizona: Min. and Sci. Press, vol. 102, 1911, p. 747; Tolman, C. F., jr., Min. and Sci. Press, vol. 99, 1909, p. 646; Higgins, Edwin, Eng. and Min. Jour., vol. 89, 1910, pp. 769, 813, 870.

the diabase has been enriched sulphide. Under favorable conditions the sulphide enrichment has gone on to the greatest depth to which development has extended. Some bodies of primary ore of commercial grade have also been developed.

In the disseminated bodies of the Miami section the original ore was sulphides of iron and copper. The copper content of the ores near the surface has been largely taken into solution and redeposited as chalcocite on the sulphides lower down. The commercial ore consists of grains of pyrite and chalcopyrite partly or wholly replaced by chalcocite. The commercial bodies of ore are blanket-like deposits overlain by leached "capping" and underlain by primary mineralization too lean in copper content to be classed as commercial ore.

An exceptional type of ore is that of the Black Warrior mine, which is oxidized ore cementing dacite tuff or breccia.

To the present time the main production has been from the Globe end of the district.

The ores in the Globe end of the district vary greatly in copper content, the grade to be treated at any given time depending largely on the possibility of profitable treatment. In general ores of as low grade as can be handled with reasonable profit are mined. During 1911 the ores of the district yielded about 3.35 per cent of copper, with about 24 cents in gold and silver per ton. The mines of the district produced 585,408 tons of concentrating ore yielding an average of 2.2 per cent copper and 122,702 tons of smelting ore yielding an average of about 9 per cent copper.

The Old Dominion smelter was the only reduction plant operating in the district during the year.

The district is served by the Gila Valley, Globe & Northern Railway, a branch of the Southern Pacific.

The Old Dominion and the United Globe mines were the largest producers during the year. The average grade of ore mined and treated by the Old Dominion Co. for the last two years is shown below.

*Grade of ore mined and treated by Old Dominion Co., Arizona, in 1911.*

| | Percentage of copper. | |
|---|---|---|
| | 1911 | 1910 |
| Average smelting ore | 7.75 | 7.85 |
| Average concentrating ore | 3.50 | 3.49 |
| Average of ore mined and treated | 5.84 | 5.70 |

The average cost of refined copper for the year was 9.15 cents per pound.

The United Globe mines produced 110,578 tons of ore, yielding 8,525,433 pounds of copper, 11,459 ounces of silver, and 875.9 ounces of gold.

In the Miami end of the district the Miami and the Black Warrior mines were the only important producers.

The Miami Copper Co. began production in 1911, the first unit of the mill going into operation March 15. At the close of the year five units were in operation and the sixth was nearly equipped. The

entire plant will have a capacity of about 3,000 tons daily. The result of milling operations for the year are as follows:

*Milling operations of Miami Copper Co., Arizona, in 1911.*

| | | |
|---|---|---|
| Ore milled | tons | 445,036 |
| Percentage of copper in ore | | 2.48 |
| Concentrates produced | tons | 20,065 |
| Percentage of copper in concentrates | | 40.36 |
| Copper in concentrates | pounds | 16,195,561 |
| Copper recovered per ton of ore | do | 36.39 |
| Mill extraction | per cent | 73.37 |

From the concentrates produced the net returns of refined copper amounted to 15,385,783 pounds. Based on the net production, the cost of copper in concentrates on board cars at Miami was as follows:

*Cost of copper f. o. b. cars at Miami in 1911.*

| | Per ton of ore. | Per pound of copper. |
|---|---|---|
| Mining | $1.2134 | $0.03500 |
| Milling | .6274 | .01810 |
| General | .1706 | .00492 |
| Total | 2.0114 | .05802 |

Concentrates are shipped to Cananea, Mexico, for treatment.

The main work of the year underground was confined to preparation for and extraction of ore, but little prospecting of unexplored territory was accomplished. At the close of the year ore reserves were estimated at 18,232,000 tons, averaging 2.58 per cent copper.

In 1912 the Inspiration Consolidated Copper Co. was formed as a merger of the Inspiration Copper Co. and the Live Oak Copper Co. It is reported that this company has about 45,000,000 tons of ore developed of an average grade of about 2 per cent copper. Blocking out of the ore was continued through the year and plans were inaugurated for the construction of a mill to treat the ores.

Development work was carried on by other companies in the district.

*Mineral Creek or Ray district.*—The Mineral Creek or Ray district began important production during 1911. The output for the year was about 15,700,000 pounds. This was the first important production of copper from this district. The geology [1] of the district is very similar to that of the Globe district to the north. Paleozoic sediments have been deposited on a basement of pre-Cambrian schists. In post-Carboniferous time the region was invaded by an intrusion of diabase and later by a granitic intrusive of varying composition. After a period of erosion the area was buried beneath Tertiary volcanics and sediments. Later it was elevated, faulted, and the covering of Tertiary sediments partly removed. The ore deposits of the district are of two distinct types—those formed in the sedimentary rocks adjacent to faults and fissures, and disseminated deposits in the

[1] Ransome, F. L., Geology of the Globe district, Arizona: Min. and Sci. Press, vol. 102, 1911, p. 747; Weed, W. H., The Ray copper mining district, Arizona: Mining World, vol. 34, 1911, p. 53; Tolman, C. F., jr., Disseminated chalcocite deposits at Ray, Arizona: Min. and Sci. Press, vol. 99, 1909, p. 622.

schist and granite. The ores of both types are believed to have been introduced at the time of and closely following the granitic intrusion.

The deposits of the first type are found east of the Ray fault. The ores are mainly oxidized. To the present time important production has not been made from this type, nor have large ore reserves been developed.

The disseminated deposits occur in crushed schist and granite. The original mineralization was pyrite and chalcopyrite, but the commercial ore has resulted from secondary enrichment of the deposits produced by the leaching of the copper values from the upper portion and redepositing them as chalcocite on the sulphides lower down. This has resulted in a blanketlike deposit of commercial ore covered by a relatively barren capping and underlain by a zone of original mineralization too low in copper content to be of commercial value.

The average thickness of the leached zone or "capping" in the Ray Consolidated ground is 252 feet, and the average thickness of the ore 101 feet. Locally, especially associated with the diabase, native copper becomes of some importance.

The district is served by the Arizona & Eastern Railroad. The mines and reduction works are connected by the Ray & Gila Valley Railroad, controlled by the Ray Consolidated Copper Co.

The most extensive operations in the district were conducted by the Ray Consolidated Copper Co.

The underground work of the year was largely confined to preparation for the mining and extraction of ore, little attention being given to prospecting undeveloped territory.

At the close of the year the ore reserves were estimated as follows: Fully developed bychurn drilling, 64,700,000 tons, having an average grade of 2.16 per cent copper; fully and partly developed, 77,314,470 tons, having an average grade of 2.17 per cent copper.

The "shrinkage stope" system of mining has been applied in two portions of the property and is reported to be entirely satisfactory.

The first unit of the concentrator at Hayden was put in operation in March, and at the close of the year five units had been completed. The plant is to consist of eight units with a nominal capacity of 8,000 tons of ore per day.

The total ore treated for the year was 681,519 tons of an average grade of 1.83 per cent, resulting in a gross output of copper contained in concentrates of 15,721,520 pounds, and corresponding to an average extraction of 63.1 per cent. In the latter part of the year the extraction was considerably above the average, being 67.38 per cent for December. The average assay of concentrates produced was 22.4 per cent copper.

The average cost per pound of copper produced to the close of the year was 10¾ cents. This cost was much higher than will be normal. Early in 1912 the cost was reported as 9 cents per pound, and the management estimates that when the plant is in full operation the cost will not exceed 8 cents per pound.

The concentrates during the year were shipped to El Paso, but early in 1912 delivery to the Hayden plant of the American Smelting & Refining Co. was begun.

Early in 1912 controlling interest in the Ray Central Copper Co. was acquired by the Ray Consolidated Copper Co., and the properties will be operated together.

*Silverbell district.*—The Silverbell district of Pima County made practically no production of copper in 1911. It produced about 5,750,000 pounds of blister copper in 1910, as compared with about 10,500,000 pounds in 1909.

Important copper production began in the district in 1904, though it had produced some silver and a little copper before that date. At the close of 1911 the district had yielded about 41,800,000 pounds of copper.

Paleozoic sediments[1] have been intruded by an acid porphyry, the sedimentary formation for the most part being detached blocks entirely surrounded by porphyry. The copper deposits are of two types—contact deposits, in which the sulphides of iron and copper, together with contact silicates, garnet, epidote, etc., have replaced limestone; and disseminated deposits, in which the original ores consist of iron and copper sulphides as veinlets and small grains in the shattered porphyry. The commercial ores of the latter type in this district, as in most others, have resulted from the secondary enrichment of these deposits.

The ore mined to the present time has been principally that of the contact deposits. These ores are in general rather low-grade smelting ores. However, they are nearly or quite self-fluxing and can be treated cheaply. Development of disseminated ores has been in progress by several companies and encouraging results are reported, but there has been no important output from this type of ore.

The ores of the district are treated at the plant of the Southern Arizona Smelting Co., at Sasco. This plant was closed down August 16, 1910, and has remained idle since.

A branch of the Southern Pacific Railroad extends from Red Rock to the district.

The Imperial Copper Co. has been the main producer in the district.

*Other districts.*—Shipments of ore were continued for the Turquoise district, Pinal County, the output for the year being about 3,300,000 pounds of copper. The Paleozoic sediments[2] of the district have been extensively faulted and intruded by monzonitic porphyries. The copper deposits of the district may be grouped as follows:

(1) Oxidized blanket deposits connected with thrust faulting, exemplified by the ore bodies of the Germania and Mary mines. (2) Pyritic deposits with some associated bodies of oxidized ore in the Cambrian dolomitic limestone and shale, exemplified by the Mame and Leadville mines. (3) Pyritic deposits with associated bodies of oxidized or enriched ore in Carboniferous limestone, exemplified by the Copper Belle and other mines near Gleeson.

The Big Bug district of Yavapai County also contributed considerably to the copper output.

### CALIFORNIA.

In 1911 California produced 35,835,651 pounds of blister copper, as compared with 45,760,200 pounds for 1910. The reduction in output for the State is due to the necessity of eliminating from the smelter smoke ingredients injurious to vegetation. This resulted in the shutting down of all but one of the smelters in the Shasta County district.

[1] The district has been briefly described by C. F. Tolman, jr., Min. and Sci. Press, vol. 99, 1909, p. 710. Stewart, C. A., Geology and ore deposits of the Silverbell mining district, Arizona: Bull. Am. Inst. Min. Eng. No. 65, May, 1912, pp. 455-501.

[2] Ransome, F. L., The Turquoise copper-mining district, Arizona, Bull. U. S. Geol. Survey No. 530, 1912.

California was among the earliest of the Western States to make an important output of copper. Production began in the "Foothill" belt about 1862 and for several years was an important industry, California being second only to Michigan in its copper production. In a few years, however, the industry declined, and California did not have important rank as a copper producer until 1897, when production from the Shasta County district began. Since that time there has been a steady and important output from the State. The production for the early years has been ascertained from the best sources available, and adding to this the known production since 1882, it is found that to the close of 1911 California has produced about 480,970,000 pounds of copper, or 2.90 per cent of the output of the country since 1845. In 1911 the output was 3.27 per cent of the total production of the United States. In total output the State ranks fifth among the copper producers and for 1911 it ranked sixth. Five plants in the State treated copper ores in 1911, though several of these were operated for only a short period.

The main production has come from two districts, though numerous other districts have made small outputs, and copper minerals are widely distributed over the State. The largest producer has been the Shasta County district and the next most important the "Foothill" district.

*Shasta district.*—The Shasta County copper belt is situated in the Klamath Mountains, at the head of the Sacramento Valley, a few miles north of the town of Redding. Sacramento River crosses the belt, separating it into an eastern and a western portion, the eastern portion containing the Bully Hill and the Afterthought districts; and the western, the Iron Mountain and the Little Backbone districts. Placer mining was carried on in the district in the early days of mining in the State, and later considerable silver was produced from the gossan outcrop of the copper deposits. Although copper minerals have been long known from the district, it was not until 1897, when the Mountain Copper Co. (Ltd.), began production at Iron Mountain, that it became an important contributor of copper. In 1911 the district produced about 29,900,000 pounds of copper, as compared with about 36,000,000 pounds in 1910. The total production to the close of 1911 has been about 365,900,000 pounds, or about 2.23 per cent of the total output of the country. In 1911 the district produced about 2.72 per cent of the total output. In total output the district ranks eighth, and in the production for 1911 it ranked ninth among the copper districts of the country.

The inclosing rock [1] of most of the ore bodies is an alaskite porphyry intrusive of Mesozoic age. The ore minerals have replaced this rock along zones of shearing. In the western district the ores thus far developed are large, flat lying, more or less tabular bodies of no great vertical extent. In the eastern district they have more the character of veins and, locally, form deposits in the adjoining sediments. The ore in the western district is pyrite, with a small percentage of chalcopyrite and varying amounts of sphalerite. In he eastern district sphalerite becomes an important constituent.

[1] Diller, J. S., Redding folio (No. 138), Geol. Atlas U. S., U. S. Geol. Survey, 1906; Bull. U. S. Geol. Survey No. 213, 1903, pp. 123-132; Bull. U. S. Geol. Survey No. 225, 1904, pp. 169-179. Graton, L. C., The occurrence of copper in Shasta County, Cal.: Bull. U. S. Geol. Survey No. 430, 1910, p. 71.

Rich secondary sulphide ores were found underlying the gossan at Iron Mountain and Bully Hill, but these have been exhausted.

The ores carry values in precious metals, those of the eastern district being rich in them. The average metal content of the copper ores from the district for 1911 was 3.7 per cent of copper, with $1.80 per ton in precious metals.

The producing companies in 1911 were the Mountain Copper, the Balaklala, and the Mammoth. All of the ore is smelted in the district, except that of the Mountain Copper Co., which during 1911 was treated at its Martinez plant on San Francisco Bay. In addition to local ores the smelters treated ores from Nevada, Idaho, and Oregon, and ore and matte from other districts of the State. A large tonnage of the low-grade gold quartz ores of the districts was used by the smelters to flux their ores. The pyritic process of smelting is practiced successfully in the district.

Two smelters were operated in the district in 1911. The Mammoth smelter at Kennett operated throughout the year. It is reported that the bag house has proven effective in eliminating the injurious substances from the smelter fumes and it is expected that a considerable revenue will eventually result from the materials collected in the bag house, though a satisfactory process for the treatment of these materials has not yet been developed.

It is reported that the tonnage of ore developed nearly equaled that extracted. The extraction was 270,331 tons. The grade of the newly developed ore is reported as somewhat higher than the average of the old reserves.

A new haulage tunnel, known as "No. 5," has been driven 105 feet below the "No. 3" haulage tunnel. The tunnel is of sufficient size for the operation of 26-ton electric locomotives and the ordinary narrow-gage railway cars.

The Balaklala smelter at Coram was closed in July by order of the federal court, on the ground that the fumes were injuring vegetation. The company had installed the Cottrell process of treating the fumes, but in the opinion of the court this treatment did not render the fumes harmless to vegetation.

During the first half of 1911 the company produced 5,026,344 pounds of copper, 177,821 ounces of silver, and 4,005 ounces of gold.

The ores of the Mountain Copper Co. were treated at their Martinez plant on San Francisco Bay. The company report the following ore reserves: Iron Mountain mine, 27,979 tons; Iron Mountain mine (in store at Keswick), 37,341 tons—the whole estimated as carrying 3.75 per cent of copper; No. 8 mine, 220,000 tons, of an average value of 4.45 per cent copper.

In addition to this there is the large body of ore developed in the Hornet mine which is low grade in copper but salable for its high sulphur content.

The Bully Hill and Afterthought districts made no production during 1911. The smelter at Bully Hill was closed in 1910 on account of "smelter fume" difficulties.

Electric power is used almost exclusively at both mines and smelters.

The district is served by the Southern Pacific Railroad, short branches extending to the smelters. The Iron Mountain district is connected with the main line by a narrow-gage railroad operated by

the Mountain Copper Co., and the mines of the Mammoth Co. are connected with the smelter by a combined electric railroad, gravity tram, and steam railroad. The ores of the Balaklala mine are delivered to the smelter over a cable tramway.

*"Foothill" district.*—The "Foothill" belt is a rather extensive area of copper deposits which has its best development in Calaveras County. This belt furnished practically the entire copper production from California in the sixties. Following that period of activity, the district was inactive for many years. From 1887 to 1892 the mines made some production. The present period of activity began about 1901, and for some years the district has made important contributions to the copper output of the State.

There is no accurate record of the output of this district in the early days, but from the records of the production of the State it is estimated that to the close of 1911 it has yielded approximately 109,500,000 pounds of copper. The production for 1911 was approximately 5,500,000 pounds. In total output the district ranks eleventh, and in production for 1911 fourteenth among the copper districts of the country.

The ores,[1] consisting of pyrite and chalcopyrite, occur as lenticular bodies replacing schist. The ores vary in different parts of the district from those carrying nearly pure pyrite and chalcopyrite with very low gold and silver content to ores carrying considerable lead, zinc, and precious metal. The ores treated in the district during 1911 averaged about 4.7 per cent in copper, with about 2 cents in precious metal per pound of copper.

The matte smelter of the Penn Chemical Co. was operated in the district, and ore was shipped to custom smelters.

### COLORADO.

In 1911 Colorado produced 9,791,861 pounds of blister copper, as compared with 9,307,497 pounds in 1910. Although the State has no important producing district in which copper is the principal metal, yet it ranked ninth among the copper-producing States in 1911. The total recorded output for the State from the beginning of the industry has been 213,543,924 pounds, or 1.30 per cent of the total output for the United States since 1845. It is probable that the actual output is somewhat in excess of this figure, as some of the copper assigned in the earlier Survey reports to "lead desilverizers" should doubtless be credited to Colorado.

The main production has been derived from the treatment of mixed ores in which copper was of minor importance, including lead-silver ores and pyritic ores rich in gold and silver. The largest production in 1911, as in previous years, was from Lake County and from San Juan, Hinsdale, Ouray, San Miguel, Clear Creek, and Gilpin counties. Leadville and the San Juan-Ouray districts have been the greatest producers of copper. Much of the output is recovered as matte in lead furnaces.

### IDAHO.

During 1911 Idaho produced 4,514,116 pounds of blister copper, as compared with 6,877,515 pounds in 1910. The State has made a small and irregular output of copper since 1884, but only since 1903

[1] Knopf, A., Bull. Dept. Geology Univ. California, vol. 4, p. 411; Read, J. A., Econ. Geology, vol. 2, 1907, p. 380; Lang, Herbert, Eng. and Min. Jour., vol. 84, 1907, p. 909.

has it been a steady and important producer. To the close of 1911 it had a recorded output of 59,071,800 pounds.

The Coeur d'Alene district furnished most of the copper output for 1911 and has been the most productive copper district in the State. Complete figures for the copper output of the district are not on record, but the total production has been approximately 45,900,000 pounds.

The Snowstorm mine is the most important copper producer of the district. This deposit [1] consists of disseminated bornite, chalcocite, and chalcopyrite in certain beds of a pre-Cambrian quartzite; in the upper portion the deposit is oxidized. The lode varies from a few feet to 40 feet in width, and has been developed to a depth of 1,200 feet below the outcrop. Development is by tunnels. The ore, being highly siliceous, is well adapted for converter linings and consequently, previous to the introduction of basic linings, received favorable smelting rates. The shipping ore yields 3.5 to 4 per cent copper, with about 6.5 ounces of silver and a little gold per ton.

The Elder Creek district in Custer County made a considerable production in 1911, the main producer being the Lost Packer mine. The deposit [2] is a fissure vein composed of iron and copper sulphides in a gangue of quartz and siderite, and carrying good gold and silver values. The country rock is a mica schist that has been cut by quartz diorite and allied rocks, some of which are older and others younger than the ore vein. The Lost Packer smelter was operated for a short period in 1911.

The State contains other promising copper deposits, but owing to lack of development or poor transportation facilities they have not been active since the decrease in the price of copper in 1907.

### MICHIGAN.

The production of copper in Michigan in 1911 was 218,185,235 pounds, as compared with 221,462,984 pounds in 1910.

The mining of copper in Michigan antedates the earliest visits of European explorers to the region. The production on a commercial basis, however, dates from 1845, since which time the district has been a steady producer and an important factor in the copper industry of the world. To the close of 1911 Michigan has produced 4,974,605,378 pounds of copper, or 30 per cent of the output from the United States since 1845. For many years subsequent to 1845 Michigan was the most important copper-producing State, and in total output it is second only to Montana. The entire output is from the Keweenaw or Lake Superior district.

In the value of metal output, in the profits resulting from this output, in the development of mining and metallurgical processes, and in the general high standing of the companies conducting the operations, the district takes high rank among the great mining camps of the world. Previous to the perfection of the electrolytic process of refining, "Lake" copper enjoyed the distinction of being the highest grade produced, and even to the present time it sells at a figure slightly higher than the copper from other districts.

---

[1] Ransome, F. L., and Calkins, F. C., The geology and ore deposits of the Coeur d'Alene district, Idaho: Prof. Paper U. S. Geol. Survey No. 62, 1908, pp. 150–152.

[2] Umpleby, J. B., Bull. U. S. Geol. Survey No. 530-G, 1912.

Although the district has been an active producer for 65 years, most of the older mines still have large reserves of ore and new mines are being opened, while much territory remains to be prospected. Moreover, it is claimed that a large tonnage of the mill tailings produced when milling methods were less efficient than at present can be re-treated at a profit.

Perhaps the most important developments of the last few years are those in the southern part of the district, where the Lake mine and neighboring properties have disclosed what may prove to be large bodies of ore in a section of the district that hitherto has been less promising than the more fully developed area to the north. The deposits of this section are, however, characteristically "bunchy" and further development will be necessary to prove their value. Although the exhaustion of some of the older mines is in sight, yet it seems probable that the district has as long a life before it as any producing district in the United States.

The Lake Superior region is unique in being the only district from which a large output is derived from native copper. The rocks[1] of the district comprise a thick series of rather basic lava flows and intercalated beds of conglomerate and sandstone of pre-Cambrian age. These have been tilted so that they have a northwest dip, usually rather steep, and strike in a general northeast-southwest direction. The copper occurs in the cellular portion of the lava flows, which form the amygdaloid lodes, and as a cement and to some extent a replacement of the conglomerate pebbles forming the conglomerate lodes. Copper also occurs in fissures crossing the formations, but at present these are of little commercial importance, though in the early days of the district considerable copper was derived from this type of deposit. A little native silver occurs with the copper. The lodes are of low grade, but characterized by great extent and rather uniform distribution of the metallic content. This, together with the fact that the ore is susceptible of high concentration with low cost of refining the resultant "mineral," makes it possible to work these low-grade deposits at a good profit. The native copper occurs in the lodes in masses varying from microscopic size to bodies weighing hundreds of tons. The richest lode mined at present carries but 1.5 per cent copper, and the poorest rock treated yields but little above five-tenths of 1 per cent of metal. For this low-grade ore to be profitable it must be handled on a large scale; this has resulted in the construction of the immense plants that characterize the Lake district. The lodes are worked for the most part through inclined shafts, though some of the deeper deposits are opened by vertical shafts. The workings have been extended in some cases to a mile in vertical depth, or about a mile and a half down the lode. Pillars of rock are left to keep the lodes open, and dry walls constructed from the waste sorted underground serve the same purpose in some of the mines. Much timber, however, is required in some of the mines, especially those operating on the conglomerate lodes.

The rock coming from the mines is crushed by steam stamps and concentrated, producing "mineral" containing an average of about

[1] For detailed description of the Keweenaw series see Irving, R. D., Mon. U. S. Geol. Survey, vol. 5; Geol. Survey Michigan, vols. 5 and 6; Rickard, Eng. and Min. Jour., vol. 88; Pumpelly, Raphael, Geol. Survey Michigan, vol. 1, 1873; Lane, A. C., and Hubbard, L. L., Geol. Survey Michigan, vol. 4, 1898; Reminger, C., Geol. Survey Michigan, vol. 5, 1905; Rice, Claude T., Copper mining at Lake Superior: Eng. and Min. Jour., vol. 94, pp. 119, 171, 217, 307, 365.

65 per cent copper. This is subjected to a combined smelting and refining process. A small amount of "mass" and "barrel work" copper are sorted out at the mine and go direct to the smelter. A portion of the output is refined electrolytically; this consists of copper sufficiently argentiferous to make the recovery of silver profitable, and of copper containing so high a percentage of impurities that further refining is necessary for certain uses. During 1910 slightly over 20 per cent of the output was refined electrolytically.

Silver in important amount is recovered only from the copper treated electrolytically. The average recovery per ton of rock from which the copper was refined electrolytically was approximately 0.216 fine ounce.

In the following table is given the production of individual companies compiled from their annual reports, together with the cost of production and the price received for the copper. The average cost of production for the district was approximately 9.9 cents per pound, and the average price received was 12.7 cents per pound, or an average profit of 3.34 cents per pound.

Approximately 15,500,000 pounds of copper, about 13 per cent of the total, was produced at a loss, about one-half of this being produced by the Tamarack Mining Co. and a considerable part of the remainder by companies that are still in the development stage.

*Production of copper by Michigan mines for 1910 and 1911, in pounds, compiled from the annual reports of the producing companies.*[a]

| Company. | 1910 | 1911 | Cost per pound, 1911. | Price received per pound, 1911. | Profit (+) or loss (−), 1911. |
|---|---|---|---|---|---|
| | *Pounds.* | *Pounds.* | *Cents.* | *Cents.* | *Cents per pound.* |
| Ahmeek | 11,844,954 | 15,196,127 | 7.17 | 12.78 | +5.61 |
| Allouez | 4,655,702 | 4,780,494 | 13.30 | 12.822 | − .478 |
| Baltic | 17,549,762 | 15,370,449 | 9.09 | 12.54 | +3.45 |
| Calumet and Hecla | 72,059,545 | 74,130,977 | 8.52 | 12.82 | +4.30 |
| Centennial | 1,572,566 | 1,493,834 | 12.69 | 12.842 | + .148 |
| Champion | 19,224,124 | 15,639,426 | 9.63 | 12.54 | +2.91 |
| Franklin | 966,353 | 820,203 | ..... | 12.516 | ..... |
| Gratiot | 265,869 | 14,275 | ..... | ..... | ..... |
| Hancock | ..... | 754,749 | ..... | ..... | ..... |
| Isle Royale | 7,567,399 | 7,490,120 | 10.850 | 12.38 | +1.53 |
| La Salle | 472,100 | 280,598 | ..... | 12.70 | ..... |
| Mass | 1,321,885 | 1,326,898 | ..... | 12.76 | ..... |
| Mohawk | 11,412,066 | 12,091,056 | 10.399 | 12.63 | +2.231 |
| Osceola | 19,346,566 | 18,388,193 | 9.28 | 12.72 | +3.44 |
| Quincy | 22,517,014 | 22,252,943 | ..... | 12.725 | ..... |
| Superior | 3,181,041 | 3,236,233 | 15.31 | 12.652 | −2.658 |
| Tamarack | 11,063,606 | 7,494,077 | 15.56 | 12.71 | −2.85 |
| Trimountain | 5,694,868 | 6,120,417 | 11.55 | 12.54 | + .99 |
| Victoria | 1,164,564 | 1,303,331 | ..... | ..... | ..... |
| Winona | ..... | 1,275,675 | ..... | ..... | ..... |
| Wolverine | 9,617,168 | 9,408,960 | 7.586 | 14.10 | +6.514 |
| Average | ..... | ..... | 9.428 | 12.773 | +3.345 |

[a] Since this table includes mines reporting their output both for the calendar and for the fiscal years, and since some of the companies report the refined copper equivalent of mineral produced and others report refined copper, the amounts do not necessarily agree with the total of either mine or smelter output.

The average copper yield per ton of rock milled during 1911 was 20 pounds, as compared with 20.5 for 1910. The average copper recovery from conglomerate rock for 1911 was 28.4 pounds per ton and for amygdaloid 17.7 pounds per ton. The copper derived from the two types, respectively, was 30 and 70 per cent.

During 1911 the rock milled amounted to 10,978,827 tons, as compared with 10,869,561 tons for 1910.

The change in grade of ore handled by the Lake companies is shown in the following table. The figures are compiled from the annual reports of the companies.

*Tonnage and yield of ore milled by Michigan copper companies in 1910 and 1911, compiled from the annual reports of the producing companies.*

| Company. | 1910 | | 1911 | |
|---|---|---|---|---|
| | Tonnage. | Yield per ton. | Tonnage. | Yield per ton. |
| Ahmeek | 530,365 | 22.33 | 598,549 | 25.4 |
| Allouez | 247,119 | 18.84 | 288,610 | 16.56 |
| Baltic | 781,419 | 22.46 | 696,795 | 22.06 |
| Calumet and Hecla | 2,795,514 | 25.77 | 2,909,972 | 25.47 |
| Centennial | 102,133 | 15.40 | 86,543 | 17.26 |
| Champion | 722,051 | 26.62 | 734,392 | 21.296 |
| Franklin | 113,859 | 8.49 | ..... | ..... |
| Gratiot | 28,522 | 9.32 | 1,347 | 10.60 |
| Hancock | ..... | ..... | 41,449 | 18.21 |
| Isle Royale | 520,860 | 14.53 | 457,440 | 16.4 |
| La Salle | 35,520 | 13.29 | 18,940 | 14.77 |
| Mass | 90,747 | 14.59 | 73,475 | 17.58 |
| Mohawk | 802,537 | 14.22 | 802,548 | 15.07 |
| Osceola | 1,217,720 | 15.90 | 1,246,596 | 14.8 |
| Quincy | ..... | ..... | 1,382,524 | 16.10 |
| Superior | 140,514 | 22.64 | 162,599 | 19.90 |
| Tamarack | 525,554 | 21.10 | 392,338 | 19.1 |
| Trimountain | 317,209 | 17.95 | 347,885 | 17.59 |
| Victoria | 122,497 | 9.51 | 126,894 | 10.53 |
| Winona | ..... | ..... | 97,445 | 13.0912 |
| Wolverine [a] | 388,476 | 24.75 | 401,308 | 23.45 |

[a] Figures are for fiscal year ending June 30, 1911.

The district is well located for cheap working of the mines. The Great Lakes furnish cheap transportation for both coal and copper, the Lake transportation being brought into the heart of the district by Portage Lake and the Houghton ship canal. The district is served by the Mineral Range, Copper Range, and Keweenaw Central Railroads and is connected with the main lines of traffic by the Chicago, Milwaukee & St. Paul and the South Shore & Atlantic railroads.

The proposed consolidation of the companies controlled by the Calumet & Hecla interests was abandoned during the year owing to the objection to such a consolidation by stockholders of some of the companies.

### MONTANA.

The output of blister copper from Montana in 1911 was 271,814,491 pounds, as compared with 283,078,473 pounds in 1910. The State thus again ranks second to Arizona in copper production.

The first record of production of copper from Montana is for 1868, but the State did not become an important contributor of this metal until 1880. Since that time there has been a steady and rapid increase in the copper output. To the close of 1911 the State has yielded 5,598,253,884 pounds, or 34 per cent of the total output of the United States since 1845. In total production the State ranks first and in the output for 1911 it ranked second. The Butte district has furnished nearly the entire output.

Three copper-smelting plants were operated in Montana in 1911: The smelter of the East Butte Mining Co., at Butte, and the smelters of the Anaconda Copper Co., at Anaconda and at Great Falls.

*Butte district.*—In 1911 the Butte district, Silver Bow County, produced about 271,200,000 pounds of copper, or about 24.72 per cent of the total output of the country.

The presence of copper minerals in the district had been known since the discovery of gold in 1864, and attempts were made to treat the ores as early as 1866; but it was not until the late seventies that the district began to attract attention as a copper camp, and large production did not begin until a railroad reached the district in 1881. To the close of 1911 the Butte district has produced about 5,586,200,000 pounds of copper, or 34 per cent of the total output of the country since 1845. In total production and in the output for 1910 it ranks first among the copper-producing districts of the United States.

The copper ores[1] of the district occur as replacement veins in a granitic rock known technically as quartz monzonite. These veins form complex systems of slightly different ages.

The principal original ore minerals in the copper veins are pyrite, chalcopyrite, enargite, bornite, chalcocite,[2] with varying amounts of sphalerite. It has been generally considered that the commercial ore has resulted from the process of secondary enrichment and that the original mineralization was too low in copper content to be of commercial importance; but more recently most of the geologists of the district have considered that all the ore minerals in the deeper levels are of primary origin—that is, that they were deposited from ascending solutions, and that only the upper part of the deposit has been effected by secondary enrichment resulting from descending solutions. This conclusion, however, does not appear as yet to have been generally accepted and a more detailed description and discussion of the facts on which it is based than has yet been published is highly desirable. The ores may be divided into two general classes as regards treatment: The sulphide-quartz smelting ores, and the concentrating ores consisting of altered quartz monzonite impregnated with grains of sulphide. In the early days of mining in the district chalcocite was by far the most important copper mineral. With increase in depth of the workings, however, the amount of copper derived from enargite has increased until it probably nearly equals the amount derived from chalcocite.

The grade of ore mined in the district is regulated to a considerable degree by the possibility of profitable treatment. An increase in the price of copper or a decrease in the cost of mining and treatment permits the mining of lower grade ores. In 1911 the average yield was 3.17 per cent copper, as compared with 3.13 in 1910, 3.08 per cent in 1909, and with 3.3 per cent in 1908. In 1911 smelting ores averaging 6.3 per cent copper furnished about 26 per cent of the output derived from ores, and concentrating ores averaging 2.56 per cent furnished about 74 per cent. The ores averaged 2.20 ounces

[1] Weed, W. H., Bull. U. S. Geol. Survey No. 285, 1905, p. 112. Weed, W. H. Geology and ore deposits of the Butte district, Montana; Prof. Paper U. S. Geol. Survey No. 74, 1912. Kirk, C. T., Conditions of mineralization in the copper veins of Butte, Mont.: Econ. Geology, vol. 7, p. 35.

[2] Sales, Reno H., Econ. Geology, vol. 5, 1910, p. 681.

silver and 0.0071 ounce gold per ton, the precious metal content reducing the cost of copper about 2 cents per pound.

Owing to the unfavorable copper market, the Anaconda Copper Co. curtailed its output to some extent, especially during the early part of the year. Advantage was taken of this curtailment to do an unusual amount of repair and development work. Several of the shafts were retimbered and equipped for hoisting with compressed air and the electric haulage system was extended. It is reported by the company that the tonnage of ore developed was much in excess of the quantity extracted.

The mines of the company produced during the year 3,844,070.20 tons of ore and 4,602.61 tons of precipitates, or a total of 3,848,672.81 tons.

The reduction works treated for all companies during the year 3,154,035.94 dry tons of ore and other cupriferous material at Anaconda and 1,101,777.84 dry tons of ore and other cupriferous material at Great Falls. Of this quantity, 3,756,235.05 tons of ore furnished from the company's mines, 499,077.33 tons of purchased ore, together with 501.40 tons of precipitates from the Old Works, were treated, from which there was produced 191,573,780 pounds of fine copper, 8,510,122.14 ounces of silver, and 40,546.216 ounces of gold at Anaconda, and 67,833,313 pounds of fine copper, 1,221,439.21 ounces of silver, and 8,403.57 ounces of gold at Great Falls, or a total production of 259,407,093 pounds of fine copper, 9,731,561.35 ounces of silver, and 48,949.768 ounces of gold.

In the North Butte property important bodies of ore were developed, though the tonnage developed did not equal that extracted. At the close of the year the company reported ore reserves as 710,920 tons, with an average assay value of 4.50 per cent copper aud 4.25 ounces of silver per ton.

During the year there were shipped 420,203 wet tons of ore and there were treated at the smelter 410,694 dry tons of ore, of which 27,114 dry tons, or 6.6 per cent, were first class and 383,580 dry tons, or 93.4 per cent, were second class. This ore produced 24,816,669 pounds of fine copper, 1,134,300 ounces of silver, and 1,280.9 ounces of gold.

The East Butte Co. mined 95,910 tons of ore, averaging 5.62 per cent copper. Of this output, 65,038 tons averaged 6.9 per cent and 30,872 tons averaged 2.86 per cent copper per ton; or, in other words, 68 per cent of the total was first-class ore and 32 per cent of the total was second-class ore.

The smelter treated 143,045 tons of ore, producing 12,167,363 pounds of copper, 396,524 ounces of silver, and 17,959 ounces of gold.

The average cost of production was 9.46 cents per pound of copper.

The district is served by three trunk lines of railroad, and a private standard-gage line connects the mines with the Washoe smelter at Anaconda. Much of the timber used in the district comes from the extensive timberlands controlled by the Amalgamated Co. Coal is also largely derived from the mines owned by this company in Montana and Wyoming. For power purposes electric power derived from Missouri River and other streams is largely replacing steam power.

### NEVADA.

The production of blister copper in Nevada in 1911 was 65,561,015 pounds, as compared with 64,494,640 pounds in 1910.

The earliest record of the production of copper in Nevada was for 1873, but it did not become an important factor in the copper industry until 1908, when production from the Ely district began.

To the close of 1911 the State has a recorded production of 203,500,112 pounds, or 1.24 per cent of the output of the country since 1845. To this should probably be added a small but unknown quantity produced as bluestone in the early days of mining in the State and used locally in the treatment of gold and silver ores. In total production Nevada ranks eighth and in the output for 1910 fifth among the copper-producing States.

*Ely district.*—The Ely district, White Pine County, was the only important producing district in the State in 1911. Although it has long been known that the district contained copper deposits, active development on an important scale began but a few years ago and important production did not begin until 1908, when the Steptoe Valley smelter and concentrating plant was completed.

During 1911 the district produced about 64,900,000 pounds of blister copper, and to the close of 1911 the output has been about 189,900,000 pounds. The district has yielded 1.16 per cent of the total output of the country since 1845, and it produced 5.92 per cent of the output of 1911. In total production it ranks tenth and in the production for 1911 sixth among the copper districts of the country.

The district is in the Egan Range, the geology [1] of which may be summarized as follows: Paleozoic limestones and shales have been invaded by a granitic intrusive technically known as quartz monzonite porphyry, probably of mesozoic age. Later the area was buried beneath lava flows which have been in large part removed by erosion.

The copper ores are of two types, replacement deposits in limestone near the porphyry contact and disseminated deposits in porphyry. The deposits in limestones thus far developed have been principally oxidized ores, and there has been but small production from this type. In the disseminated type the original ores consisted of small veinlets and grains of pyrite and chalcopyrite disseminated through the greatly shattered and highly altered porphyry. The commercial ore has resulted from the secondary enrichment of these deposits by the removal of the copper from the upper portion and redeposit as chalcocite on the sulphides lower down, the commercial ore consisting of grains of pyrite and chalcopyrite partly or entirely replaced by chalcocite. The leached capping is of varying thickness, but for a part of the deposit it is thin enough to permit of its removal and the mining of the ores by steam shovels; for the remainder underground methods will be employed.

For the Eureka section the average thickness of the capping is 87.1 feet, and of the profitable ore 190 feet; for the Hecla area the capping is of an average thickness of 101.4 feet and the ore is 280.3 feet thick, and for the Liberty area the capping is 154.7 feet thick and the ore is 193.3 feet thick.

[1] Lawson, A. C., Bull. Dept. Geology Univ. California, No. 4, p. 284. A detailed report on the district is in preparation by the United States Geological Survey.

During the year 2,745,524 tons of copper ore mined in the district produced concentrates containing 65,262,796 pounds of copper. The average recovery in concentrates per ton of ore from the district was 1.19 per cent of copper, with about 17 cents in gold and silver per ton of ore. Smelting ores amounting to 31,354 tons contained 2.8 per cent of copper, with 33 cents in gold and silver per ton.

The Nevada Consolidated Copper Co. and the Giroux Consolidated Mines Co. were the most active operators in the district, the production being mainly by the former company.

The production of the Nevada Consolidated Co. was mainly from the Eureka pit, though a small output was made from the Liberty pit and from the Veteran mine, which was operated toward the close of the year.

The ore reserves on January 1, 1912, are reported as 40,853,371 tons, with an average copper content of 1.662 per cent.

The smelting plant at McGill was equipped for the use of oil instead of coal, and basic lined converters were also introduced.

The following table shows the results of operations at the concentrator for the 15 months ending December 31, 1911:

*Operations of Nevada Consolidated Copper Co. for fiscal period of 15 months ending Dec. 31, 1911.*

| | | |
|---|---|---|
| Ore treated (dry) | short tons | 3,338,242 |
| Average copper assay | per cent | 1.80 |
| Percentage of extraction (copper) | do | 67.59 |
| Ratio of concentration | | 11.34 |
| Assay value in gold | ounces | .013 |
| Assay value in silver | do | .079 |
| Extraction of gold | per cent | 57.72 |
| Extraction of silver | do | 45.92 |
| Average gold and silver recovered per ton of ore | cents | 17.35 |
| Average copper in concentrates | per cent | 13.80 |

The net production of copper for the 15 months amounted to 78,541,270 pounds at a cost, after providing for depreciation and all other charges, of 6.69 cents per pound.

Operations of the Giroux Consolidated Mines Co. for the year were confined to development work.

The new shaft in the Alpha territory was completed to the 1,400-foot level. Connections were made with the old Alpha workings and the ore body explored on the 770-foot, 1,000-foot, and 1,200-foot levels. The crosscut was extended 420 feet from the shaft on the 1,400-foot level.

A serious fire in the shaft on August 22, 1911, delayed the development in this territory.

The Morris-Bunker Hill porphyry mine was prepared for the production of ore. In May, 1912, the company began shipment of concentrating ore to the Steptoe concentrator, the contract calling for a minimum of 800 tons and a maximum of 1,200 tons daily.

The management reports 10,291,000 tons of fully and partly developed ore of an average copper content of 2 per cent and 6,599,000 tons of fully and partly developed ore of an average copper content of 1.65 per cent.

Development work was in progress by other companies in the district.

The district is served by the Nevada Northern Railroad, controlled by the Nevada Consolidated Copper Co., connecting with the Central Pacific Railroad at Cobre.

All the raw materials for smelting operations except fuel are from the district. Siliceous ore is obtained from the "dike" of siliceous copper ore in the Copper Flat pit, and limestone for fluxing is quarried near the smelter.

Oil has replaced coal as a fuel in the smelting operations.

*Yerington district.*—At the Yerington district in Lyon County development was continued during the year, but no important production was made.

Copper ores have been mined in the district for many years. In the early days considerable natural bluestone was mined and used in the treatment of gold ores at Virginia City. Later an attempt was made to smelt the ores, but with little success. No accurate data of the total output of the district has been compiled, though it has not been large. During the last few years development of ore by several companies has been in progress and it is reported that considerable ore carrying copper values of 3 per cent or better have been opened.

The ores of the district according to Ransome [1] are of three types of occurrence:

(1) Irregular bodies formed by metasomatic replacement of limestone and genetically associated with metamorphism of a kind usually attributed to contact action of intrusive rocks; (2) metasomatic vein deposits in altered limestone; and (3) metasomatic vein deposits in granodiorite.

The most important developments are of ore bodies of the first type. The original sulphides of these are pyrite and chalcopyrite in various proportions, with a gangue of pyroxene, amphibole, epidote, garnet, and calcite.

During the year the Mason Valley Mines Co. completed an 800-ton smelting plant located near Wabuska. This plant was blown in early in 1912.

The district is served by the Nevada Copper Belt Railway, which connects with the Goldfield branch of the Southern Pacific at Wabuska.

A small production was made from several other districts in the State, mostly from lead-copper and siliceous ores.

### NEW MEXICO.

The production of blister copper in New Mexico in 1911 was 2,860,40 pounds, as compared with 3,784,609 pounds in 1910.

Production of copper from New Mexico began in the last years of the eighteenth century, native copper from the mines of Grant County being carried to Mexico City and coined into money. A little copper is reported for about the year 1860, but New Mexico did not have a steady output until after 1880 and did not become an important factor in production until 1900. From 1845 to 1911 New Mecixo has a recorded output of 95,183,563 pounds of copper, or 0.58 per cent of the output of the country since 1845. The principal production has been from the districts in Grant County.

*Santa Rita district.*—The Santa Rita district, in Grant County, made but a small production in 1911. This was probably the first district

[1] Ransome, F. L., The Yerington district, Nevada: Bull. U. S. Geol. Survey No. 380, 1909, p. 99.

in the West from which important copper production was made, the output beginning in the closing years of the eighteenth century, the metal going to Mexico for coinage. There are no accurate records of the production for this early period of operation, but from the best sources available it is estimated that the total production to the close of 1911 has been approximately 103,000,000 pounds.

The geology[1] of the district is rather complex. The sedimentary series, consisting of quartzite, shales, and limestone, has been invaded in post-Cretaceous time by a granitic rock technically known as quartz monzonite porphyry. After a period of erosion the area was buried beneath Tertiary volcanic flows, which in turn have been largely removed by erosion.

The copper deposits may be divided into two types, contact deposits and disseminated deposits. The contact deposits occur as replacement of limestone near the porphyry contact, and have been most extensively worked in the Hanover end of the district.

In the disseminated deposits the ore minerals occur as small veins and grains of mineral in shattered quartzite and highly altered porphyry. Unlike many of the disseminated deposits, much of the copper occurs native and as the oxide, though chalcocite ores are also abundant. To the present time the main production has come from shallow workings following high-grade streak of native copper oxide and chalcocite ores.

Since 1909 the Chino Copper Co. has been actively developing the main mineralized area by means of churn drills, and production by this company began late in 1911. The management gave the developed ore at the close of the year as 54,970,646 tons, of an average grade of 2.24 per cent copper.

The average thickness of the ore body is 107 feet and the average thickness of the barren capping is 82 feet. It is stated that nearly 60 per cent of the developed ore can be extracted by steam-shovel methods, and a part of the area has already been stripped and is being mined by this method.

The first section of the mill at Hurley was placed in operation in October, and at the close of the year two sections were in operation. When completed the mill will consist of five sections, with a capacity of 5,000 tons of ore per day.

The yield of copper in concentrates from the ore treated to the close of the year was about 24.5 pounds to the ton. For the second quarter of 1912 the yield was 23.74 pounds per ton, the recovery being 62.69 per cent of the assay content.

The cost of producing copper for the year was a little under 10 cents per pound. In the second quarter of 1912 the cost was 8.02 cents per pound. The concentrates are shipped to El Paso for treatment.

The district is served by a branch of the Santa Fe Railway connecting with the main line and with the Southern Pacific at Deming.

*Burro Mountain district.*—The Burro Mountain district, southwest of Silver City, made but a small production in 1911. The total production from the district has probably been about 10,000,000 pounds of copper.

---

[1] Lindgren, W., Graton, L. C., and Gordon, C. H., Ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, p. 305.
A report on the geology of the Silver City quadrangle is in preparation by the United States Geological Survey.

The Burro Mountain[1] consists of a pre-Cambrian complex that has been intruded by monzonite prophyry. The copper ores occur mainly as impregnations and replacements along irregular fractures and zones of crushing. The primary sulphide is cupriferous pyrite, but the workable deposits have resulted from the secondary enrichment of the primary ores.

A considerable tonnage of ore has been developed in the district, but important production will probably not be made for some time.

The Lordsburg district, with an output of about 2,400,000 pounds, was the only other important producer in the State.

### TENNESSEE.

The production of blister copper from Tennessee in 1911 was 18,965,143 pounds, as compared with 16,691,777 pounds in 1910.

The entire output was from the Ducktown district located in the extreme southeastern part of the State in Polk County The district was one of the earliest large producers in the country. Operations began about 1850, and from that date till the close of the Civil War there was a large production from the "black-copper" ores. With the exhaustion of the rich secondary deposits attempts were made to work the lean original sulphides. These efforts met with only indifferent success, and in the late seventies the smelters shut down, thus ending the first period of activity in this district. The present period of activity began in 1890, when the Ducktown Sulphur, Copper & Iron Co. began operations. Since that time the district has been a steady producer from the primary sulphide ores. To the close of 1911 the total output of the district has been approximately 230,660,000 pounds.

The ores[2] occur as steeply dipping lenses replacing calcareous bands in schist, the ore bodies in general conforming to the dip and strike of the schistosity of the inclosing rock. The principal sulphide is pyrrhotite, with subordinate pyrite, chalcopyrite, and sphalerite. Extensive gossans cap the ore bodies, and it was the enriched zones underlying these that furnished the rich chalcocite ores that were extracted during the first period of activity.

In 1911 the ores of the district yielded a little over 32.4 pounds of blister copper per ton, or 1.62 per cent, with an average value of 0.117 cents in gold and silver per ton of ore. A part of the copper is marketed without electrolytic refining. The fact that the ores can be extracted without timbering, the cheap supply of coke and coal from Tennessee and West Virginia, and the comparatively low cost of labor, have made it possible to mine and treat these low-grade ores at a profit.

The pyritic process of smelting is practiced successfully by both companies. The low-grade matte produced by the first smelting is resmelted and brought to a proper grade for conversion.

---

[1] Lindgren, W., Graton, L. C., and Gordon, C. H., Ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, p. 321. Paige, Sidney, Metalliferous ore deposits near the Burro Mountains, Grant County, N. Mex.: Bull. U. S. Geol. Survey No. 470, p. 131.

[2] The deposits have been described by Heinrich, Carl, Trans. Am. Inst. Min. Eng., vol. 25, p. 173; Weed, W. H., idem, vol. 30, p. 452; Kemp, J. F., idem, vol. 31, p. 224; Higgins, E., Eng. and Min. Jour., vol. 86, 1908, pp. 1237–1241; Channing, J. P., Min. and Sci. Press, vol. 96, 1908, p. 97; Gottsberger, B. B., Mining World, vol. 29, 1908, pp. 911–914; Weed, W. H., Ore deposits of the Appalachian States, Bull. U. S. Geol. Survey No. 455, 1911, p. 152; Emmons, W. H., and Laney, F. B., Preliminary report on the mineral deposits of Ducktown, Tenn.: Bull. U. S. Geol. Survey No. 470, 1911, p. 151; Laney, F. B., The manufacture of sulphuric acid from smelter fumes at Ducktown, Tenn.: Mineral Resources U. S. for 1911, pt. 2, U. S. Geol. Survey, 1912.

Sulphuric-acid plants were operated by both the Ducktown Sulphur, Copper & Iron Co. and the Tennessee Copper Co. The successful operation of these plants has apparently not only solved the troublesome smelter-smoke problem, but added very materially to the revenue of the companies. The sulphuric-acid production will probably be fully as important in the future as the copper output.

The Tennessee Copper Co. treated 436,285 tons of ore from the district, which yielded 13,808,940 pounds of copper, or an average of 31.65 pounds per ton of ore. The average cost of the production of copper was 10.88 cents per pound.

The ore reserves at the company's mines at the close of the year were reported as 3,653,000 tons of available ore, and 1,380,000 tons of probable ore, a total ore reserve of 5,033,000 tons.

The district is served by a branch line of the Louisville & Nashville Railroad, the mines and smelters of the companies being connected with this by private lines.

### UTAH.

In 1911 Utah produced 142,340,215 pounds of blister copper, as compared with 125,185,455 pounds in 1910. The marked increase was due to the production from the Bingham district.

The first record of production of copper from Utah is for 1872. The State did not become an important copper producer, however, until late in the nineties, since which time the growth of the industry has been steady and rapid. The total recorded output from the State to the close of 1911 has been 797,044,788 pounds, 4.89 per cent of the output from the United States since 1845. In 1911 Utah produced 12.97 per cent of the output. In total output and in the production for 1910 it ranks fourth among the copper-producing States

Two copper-smelting plants were operated in the State during 1911, the Garfield smelter at Garfield, and the International smelter at Tooele.

*Bingham district.*—The Bingham or West Mountain district, Salt Lake County, made about 125,500,000 pounds of blister copper in 1911, as compared with about 112,000,000 pounds in 1910.

The output of the mines of the district was considerably above the smelter production. The presence of copper minerals has been known since the early days of mining in the district, but for many years operations were confined to the production of lead, silver, and gold. Not until 1896 did the mining of copper ore become of commercial importance. To the close of 1911 the district has produced approximately 590,500,000 pounds, or 3.60 per cent of the output of the country since 1845. For 1911 the district yielded 11.44 per cent of the total production. In total output the district ranks sixth among those of the country and in the production for 1911 it ranks fourth.

The ore deposits of the district [1] are closely associated with masses of monzonite intruded into a series of quartzites with intercalated beds of limestone and shale of Carboniferous age. The ores are of two types of occurrence—as irregular replacement deposits of limestone near the monzonite contact, and as disseminated deposits through altered porphyry.

[1] For detailed information see Boutwell, J. M., Economic geology of the Bingham mining district, Utah Prof. Paper U. S. Geol. Survey No. 38, 1905.

Prior to 1907 most of the copper from the district was derived from the contact deposits in limestone. These are massive bodies of pyrite carrying chalcopyrite in varying amounts. Secondary enrichment has not been of great importance in this type of deposit. The ores vary greatly in copper content and consequently the average percentage derived for a given year depends largely on the grade that can be worked at a profit at the price of copper. In 1911 the ores yielded about 2.22 per cent copper and $2.90 in gold and silver per ton of ore. About 572,000 tons of this type of ore was produced during the year, yielding about 25,400,000 pounds of copper.

The primary mineralization of the disseminated type consists of grains of pyrite and chalcopyrite disseminated through highly altered porphyry and shattered quartzite. The commercial ore is the result of secondary enrichment, the copper content near the surface being partially leached and redeposited as coatings of chalcocite and occasionally as bornite and covellite on the sulphides lower down. The commercial ore forms a blanket-like deposit covered by the leached capping and underlain by the lean primary mineralization. The average thickness of the commercial ore is stated to be 418 feet. The thickness of the capping varies greatly at different points. On the original Utah copper ground it is stated to be 80 feet, the average for the original Boston Consolidated ground is estimated to be 134 feet, and for the Pay Roll group 173 feet. The average thickness of capping over all the ore of the Utah Copper Co. is estimated at 106 feet. The secondary enrichment in the Bingham disseminated ores is less than in several of the other disseminated deposits. The ores are extracted by both steam shovel and underground methods. During the year about 5,230,000 tons of disseminated ore was mined, yielding about 1 per cent copper and about 20 cents in gold and silver per ton.

The ores were treated at the mills at Garfield and at the Ohio Copper Co.'s mill at Lark. The ores and concentrates from the district were reduced at the Garfield smelter and the International smelter. The mills of the Utah Copper Co. treated 4,680,801 tons of ore, with an average copper content of 1.51 per cent. The average extraction was 69.53 per cent, equivalent to 21.03 pounds of copper per ton of ore treated. The total production in concentrates for the year by the Utah Copper Co. was 98,436,224 pounds. The average cost of producing this copper was 7.865 cents per pound. The net value of gold and silver amounted to 1.07 cents per pound of copper. The company reported at the close of the year 229,830,000 tons of fully developed ore, 62,040,000 tons averaging 2 per cent copper, 92,130,000 tons averaging 1.6 per cent copper, and 75,660,000 tons averaging 1.30 per cent copper. Partly developed ore with an average copper content of 1.28 per cent brings the total tonnage to 301,500,000 tons, with an average copper content of 1.532 per cent.

The Utah Copper Co.'s Magma mill at Garfield has a capacity of 12,000 tons per day, and the Arthur mill, which was being remodeled during the year after the design of the Magma mill, has a capacity of 9,000 tons, giving the company a milling capacity of 21,000 tons daily.

Operations at the Ohio Copper Co.'s property were continued through the year. For the six months ending March 31, 1912, the company milled 311,067.63 tons of ore, with an average copper content of 1.176 per cent. The loss in treatment was 44.13 per cent. The smelter returns were 3,754,866 pounds of copper.

The Utah Consolidated Mining Co. shipped 162,522 tons of copper ore, averaging 2.89 per cent copper and 0.0936 ounce of gold and 0.9815 ounce of silver per ton. At the close of the year there was reported as in signt in the mine 239,650 tons of copper ore, averaging 2.24 per cent copper and 0.051 ounce of gold and 0.603 ounce of silver per ton. The ores were shipped over the aerial tram to the International smelter.

Several other companies in the district were important producers of copper and copper-lead ores.

The district is served by a branch of the Denver & Rio Grande Railroad, and the Bingham & Garfield Railway, controlled by Utah Copper Co. interests, connecting the mines at Bingham with the mills at Garfield. Cable tramways are employed to considerable extent; the ores from the Utah Consolidated mines are delivered to the International smelter in this manner, and ores from other mines are delivered to the railroad over cable tramways.

*Tintic district.*—The Tintic district in Juab County made a production of 10,900,000 pounds of blister copper in 1911, as compared with about 9,000,000 pounds in 1910. The production of copper from the Tintic district is largely incidental to the production of other metals. The amount of ore in which copper is the most important metal constituent is relatively small. There has been a small output of copper from the district for many years, but no accurate statistics of the early output are available. Tower and Smith have made an estimate of the production to 1897, and by adding to this the production since that time, compiled from the best sources available, it is estimated that to the close of 1911 the district has yielded approximately 90,900,000 pounds of copper.

The occurrence of the ores [1] may be briefly summarized as follows: The sedimentary series, consisting of limestone and quartzite, has been intruded by an extensive mass of monzonite. The ores occur as replacement deposits in the limestone near the monzonite contact, as replacement veins in the igneous rocks, and as replacement veins in the sedimentary series.

The most valuable deposits developed are of the last-named type. The fissures are usually nearly vertical, and the replacement bodies are extremely irregular in form and variable in size. The original minerals were pyrite, galena, sphalerite, and enargite, with rich silver and gold minerals in a gangue of quartz and barite.

There has been little development below the water level, which is usually below 1,600 feet in the deposits in limestone, and oxidation to this point has been rather complete. Recent developments below the water level in some of the mines have been encouraging, revealing sulphide ores of high grade.

The Centennial-Eureka mine was the most important producer of copper in 1911 as in previous years.

*Frisco district.*—The Frisco district of Beaver County made a production of about 3,600,000 pounds of copper in 1911, as compared with about 1,100,000 pounds in 1910.

The first important production of copper from the district was from the Horn Silver mine in 1889, and since that time there has been

[1] For detailed report, see Tower, G. W., and Smith, G. O., Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1899, pp. 601–767.

a production of copper from lead-silver ores and from small copper mines. The importance of the district as a copper camp dates from the starting of the mill in 1905 to treat the ores of the Cactus mine. To the close of 1911 the district has yielded approximately 32,600,000 pounds of copper.

At the present time the Cactus mine of the South Utah Mines & Smelters Co. is the only important producer of copper ores.

The ores,[1] which consist of pyrite and chalcopyrite, occur disseminated in a highly brecciated and altered area of quartz monzonite. Most of the ore is low grade and requires concentration before shipping.

The mine is equipped with a 1,000-ton mill. Concentrates are shipped to the International smelter for treatment.

In addition to the districts mentioned, several other camps contributed to the copper output of the State.

### OTHER STATES.

*North Carolina.*—North Carolina produced only 13,699 pounds of blister copper in 1911, as compared with 181,263 pounds in 1910.

*Oregon.*—Oregon produced 125,943 pounds of blister copper in 1911, as compared with 22,403 pounds in 1910. To the close of 1911 the State has a recorded output of 2,575,727 pounds of copper. The largest production in recent years has been from the Waldo district in Grant County.

*Pennsylvania.*—The blister copper production from Pennsylvania in 1911 was 661,621 pounds, as compared with 740,626 pounds in 1910. The output was from the iron mines of Lebanon County. These ores[2] carry a small amount of pyrite and chalcopyrite, which is separated by magnetic dressing of the iron ores. The sulphides are treated for their copper values.

*South Dakota.*—The smelter of the Continental Copper Mining & Smelting Co., of Hill City, was idle during 1911, and the State had practically no production of copper.

*Washington.*—Washington made a production of 195,503 pounds of blister copper in 1911, as compared with 65,021 pounds in 1910. The State contains no important producing district, the total recorded output to the close of 1911 being but 2,173,284 pounds.

The Northport smelter was not operated during the year. The Tacoma smelter was operated principally on ores from outside the State.

*Wyoming.*—Wyoming made a production of 130,499 pounds of blister copper in 1911, as compared with 217,127 pounds in 1910.

To the close of 1911 the State has a recorded output of 25,973,899 pounds.

The Encampment district, the most important producer, was not active in 1911, as the principal company, the United Smelters, Railway & Copper Co., successors to the Penn-Wyoming Copper Co., was in litigation.

Exact statistics of the output of this district are not available, but it has probably been in excess of 20,000,000 pounds.

[1] Emmons, S. F., The Cactus copper mine, Utah: Bull. U. S. Geol. Survey No. 260, 1905, p. 242.
[2] Spencer, A. C., Magnetite deposits of the Cornwall type in Pennsylvania: Bull. U. S. Geol. Survey No. 315, 1907, pp. 185–189.

The most important deposits of the Encampment district [1] occur in a zone of brecciated quartzite underlying schist. The original ore was chalcopyrite with possibly some pyrite. Secondary enrichment has produced important bodies of chalcocite in the upper workings, but these give place to chalcopyrite at depth.

## REFINERY PRODUCTION.

The refinery output of the United States was made by 13 plants, 9 of which employ the electrolytic method and 5 employ the furnace process on Lake Superior copper, the Buffalo plant employing both the electrolytic and the furnace refining method. Six of the large electrolytic refineries are located on the Atlantic tidewater, 5 Lake refineries are on the Great Lakes, 4 in Michigan and 1 in New York. Only 2 plants are located west of the Great Lakes; 1 at Great Falls, Mont., and 1 at Tacoma, Wash. In addition to these refineries, there are numerous plants in different parts of the country that make a considerable output from old copper, brass, and other alloys of copper.

The output of the regular refining plants is in the form of casting, Lake, and electrolytic copper.

### CASTING AND PIG COPPER.

Blister copper that is low in precious metals and sufficiently free from impurities for certain uses is refined by the furnace process and ordinarily cast into ingots. This copper is usually unfit for the uses requiring a high-grade copper, such as electric transmission, brass manufacture, and rolling, but is suitable for copper castings, and a large part of it is put to that use. Lake copper excepted, a comparatively small percentage of the copper output carries such low values in precious metals that, together with the value added to the copper by electrolytic refining, these values will not more than pay for the electrolytic refining of the copper; consequently the output of casting copper is small. Some blister or pig copper low in precious metals is exported without further treatment and is probably consumed without electrolytic refining. A large percentage of the casting copper, shown in the table, is from the Morenci-Metcalf district, Arizona. The pig copper is from this district and the Ducktown, Tenn., district. Both districts produce a rather high grade of blister carrying low values in precious metals, and it is found profitable to market much of it without electrolytic refining. During 1911 the production of new casting copper amounted to 22,977,534 pounds, and pig copper amounted to 36,600,269 pounds.

### LAKE COPPER.

By Lake copper as used in this report is meant the output of the Lake smelters. Considerable of this output is refined electrolytically, but most of the electrolytically-refined Lake copper is mixed with furnace-refined copper or sold as some brand of Lake copper. Of the 218,185,236 pounds of copper produced by the Lake smelters, about 43,700,000 pounds were refined electrolytically either to free it from impurities or to recover the silver content.

[1] Spencer, A. C., Copper deposits of the Encampment district, Wyoming: Prof. Paper U. S. Geol. Survey No. 25, 1904.

### ELECTROLYTIC COPPER.

Under electrolytic copper, as shown in the accompanying table, is included all new copper that was refined electrolytically, except that from the Lake district. In 1911 the production of electrolytic copper from primary materials of domestic origin amounted to 823,507,764 pounds, and that of foreign origin to 332,604,223 pounds. Electrolytic copper to the amount of 19,093,622 pounds was produced from secondary sources, making a total electrolytic production of 1,452,968,648 pounds for the year.

### SECONDARY COPPER.

Under secondary copper is considered material recovered from remelting old copper, copper scraps, etc., and copper recovered from the treatment of copper alloys or alloys that are treated without the separation of the copper. A careful canvass of plants producing secondary copper has been made by J. P. Dunlop. One hundred and fifty-three plants reported to the United States Geological Survey as making a production from secondary sources.

The total quantity of secondary copper recovered, on the assumption that the brass remelted had an average copper content of 70 per cent, was 214,208,000 pounds, of which 27,896,000 pounds was recovered by regular refining plants and the remainder by plants treating only secondary materials. At least 62,000,000 pounds was recovered from clean scrap made in the course of manufacture of copper and brass ware, so that only 152,208,000 pounds was obtained from ashes, cinders, scrap, and other material that had actually been used and discarded. Many of the railways sell or turn in their brass and copper scrap to dealers in part payment for new material, but the reports received show that the railways utilized in their own shops and foundries over 26,400,000 pounds of brass in addition to copper in other alloys.

As contrasted with lead and zinc, the uses for which copper is principally employed are such that a large percentage of the metal can be eventually recovered and returned to the trade. The period elapsing between the time when copper enters the trade and is returned as scrap varies, of course, greatly with the uses for which it is employed, and no data are available that will give even an approximation of this period. However long this period may be, it is evident that there will be an increase in the production of copper from secondary sources proportionate to the great increase in the consumption of copper. The production from old scrap in 1911 was more than 22 per cent of the domestic consumption of new copper. This compares with between 17 and 18 per cent for 1910, and between 12 and 13 per cent for 1909.

### TOTAL REFINED COPPER.

The total production of new refined copper in 1911 was 1,433,875,026 pounds. This was the largest output in the history of the industry, exceeding that of 1910 by 11,835,893 pounds.

The production of electrolytic, Lake, casting, and pig copper from primary sources and the production of secondary copper by the regular refining plants in 1910 and 1911 is shown in the following table:

*Production of primary and secondary copper by the regular refining plants in 1910 and 1911, in pounds.*

| | 1910 | | 1911 | |
|---|---|---|---|---|
| | Domestic. | Foreign. | Domestic. | Foreign. |
| PRIMARY. | | | | |
| Electrolytic | 782,171,204 | 346,133,521 | 823,507,764 | 332,604,223 |
| Lake | 221,462,984 | | 218,185,236 | |
| Casting | 68,260,688 | 4,010,738 | 22,977,534 | |
| Pig | | | 36,600,269 | |
| Total primary | 1,071,894,876 | 350,144,259 | 1,101,270,803 | 332,604,223 |
| | 1,422,039,135 | | 1,433,875,026 | |
| SECONDARY. | | | | |
| Electrolytic | 9,952,358 | | 19,093,622 | |
| Casting | 21,088,516 | | 8,803,105 | |
| Total secondary | 31,040,874 | | 27,896,727 | |
| Total output | 1,453,080,009 | | 1,461,771,753 | |

The figures for Lake copper include the Michigan copper that was electrolytically treated.

In addition to the secondary material treated by the regular refining companies, plants that treated secondary material exclusively produced a total of 186,311,000 pounds of copper as copper and in brass and other alloys of copper, making a total production of 214,207,727 pounds from secondary sources. Of this total at least 62,000,000 pounds was produced by remelting clean scrap produced in the process of manufacture of copper and brass articles.

If the output of plants treating purely secondary material is added to the production of the regular refining companies, the contribution of the United States to the world's supply of copper for 1911 is found to be 1,648,082,753 pounds.

During 1911 reports were made by the Copper Producers' Association of the monthly output of marketable copper by the regular refining plants in the United States. The following table shows the output by months and the total for the year:

*Monthly output of marketable copper in 1911, as reported by the Copper Producers' Association, in pounds.*

| Month. | Output. | Month. | Output. |
|---|---|---|---|
| January | 115,696,591 | August | 125,493,667 |
| February | 109,826,297 | September | 115,588,950 |
| March | 130,532,060 | October | 118,255,442 |
| April | 118,085,223 | November | 111,876,601 |
| May | 126,962,544 | December | 122,896,697 |
| June | 124,554,312 | | |
| July | 112,167,934 | Total | 1,431,938,338 |

## COPPER SULPHATE.

The production of hydrous copper sulphate or bluestone by the refineries of the United States in 1911 was 35,604,950 pounds, having a copper content of about 9,008,000 pounds, as compared with 29,728,143 pounds, having a copper content of about 7,521,000 pounds in 1910.

## STOCKS.

Returns from all smelting and refining companies show that the following stocks of electrolytic, Lake, casting, and pig copper were on hand at the beginning and end of the year 1911:

*Stocks of refined copper, in pounds.*

| | |
|---|---|
| January 1, 1911 | 122,803,656 |
| January 1, 1912 | 88,372,195 |
| Decrease during 1911 | 34,431,461 |

In addition to the stocks of refined copper, there were reported as at the smelters, in transit to the refineries, and at the refineries, blister copper and material in process of refining to the amount of 219,864,749 pounds January 1, 1912, as compared with 245,218,530 pounds January 1, 1911.

During 1911 the Copper Producers' Association reported the stock of the marketable copper held at all points in the United States on the first of each month. The following table shows the stocks held on the first of each month:

*Stocks of marketable copper of all kinds on hand at all points in the United States on the 1st day of each month for 1911 and on Jan. 1, 1912, as reported by the Copper Producers' Association, in pounds.*

| Month. | Quantity. | Month. | Quantity. |
|---|---|---|---|
| January | 122,030,195 | August | 137,735,858 |
| February | 142,439,490 | September | 133,441,501 |
| March | 156,637,770 | October | 140,894,856 |
| April | 162,007,934 | November | 134,997,642 |
| May | 165,555,908 | December | 111,785,188 |
| June | 165,995,932 | Jan. 1, 1912 | 89,454,695 |
| July | 157,434,164 | | |

## IMPORTS AND EXPORTS.

### IMPORTS.

The quantity of copper in unmanufactured form imported into the United States in 1911 was 334,607,538 pounds, according to the records of the Bureau of Statistics of the Department of Commerce and Labor. The imports in 1910 were 344,435,771 pounds. The following table shows the character and source of copper-bearing materials imported during 1910 and 1911:

*Imports of copper into the United States in 1910 and 1911, by countries, in pounds.*

| Country. | Ore, matte, and regulus. | | Pigs, bars, ingots, plates, old, etc. | |
|---|---|---|---|---|
| | 1910 | 1911 | 1910 | 1911 |
| United Kingdom | | | 18,649,727 | 9,004,461 |
| Germany | 961,534 | 430,518 | | |
| Spain | 4,927,830 | 5,354,142 | 25,411,393 | 28,042,257 |
| Canada | 10,034,806 | 12,919,644 | 29,016,785 | 22,442,335 |
| Mexico | 22,731,184 | 16,648,071 | 84,008,907 | 97,115,574 |
| Chile | 19,425,233 | 15,305,335 | 4,239,079 | 5,175,823 |
| Cuba | 8,858,373 | 10,787,759 | | |
| Peru | | | 40,759,887 | 42,545,939 |
| Japan | | | 18,482,989 | 20,030,447 |
| Australia and Tasmania | | | 22,913,387 | 22,426,670 |
| Other countries | 18,286,015 | 7,181,309 | 15,728,642 | 19,197,254 |
| Total | 85,224,975 | 68,626,778 | 259,210,796 | 265,980,760 |
| Grand total | | | 344,435,771 | 334,607,538 |

In 1911 ore to the amount of 367,282 tons, with a copper content of 48,310,266 pounds, and 25,649 tons of matte and regulus, with a copper content of 20,316,512 pounds, were imported. The copper imported as matte and blister included a considerable portion of the 41,000,000 pounds of ore and matte that was treated in foreign plants during the year.

According to the reports of the smelters and refineries, 332,604,223 pounds of new copper was produced in this country from foreign material.

## EXPORTS.

The exports of metallic copper from the United States in 1911 amounted to 786,553,208 pounds, according to the Bureau of Statistics. This is the largest export made in any year, exceeding that of 1910 by 78,236,665 pounds. In addition to the exports of metallic copper, the copper content of 57,915 long tons of ore, matte, and regulus was exported in 1911, as compared with the content of 43,784 long tons in 1910.

*Exports of domestic copper from the United States in 1909 and 1910, by countries, in pounds.*

| Country. | Ingots, bars, plates, and old. | |
|---|---|---|
| | 1910 | 1911 |
| United Kingdom | 98,030,213 | 108,061,603 |
| Austria-Hungary | | 44,200,202 |
| Belgium | 7,176,258 | 5,125,004 |
| France | 116,193,850 | 135,038,893 |
| Germany | 175,861,028 | 190,428,008 |
| Italy | 34,110,237 | 38,216,773 |
| Netherlands | 221,764,806 | 230,693,649 |
| Russia in Europe | 6,848,311 | 15,601,688 |
| Other Europe | 42,203,861 | 9,254,363 |
| Canada | 5,628,487 | 8,931,582 |
| Other countries | 499,492 | 1,001,443 |
| Total | 708,316,543 | 786,553,208 |

The report of the Copper Producers' Association, which is based on a slightly different period, shows a delivery of 754,902,233 pounds for export.

## CONSUMPTION.

The apparent consumption of refined new copper in the United States in 1911 was about 681,700,000 pounds. In 1910 it was about 732,400,000 pounds. The method employed in determining the quantity of copper retained for domestic consumption is shown in the following table. It does not take into consideration stocks of copper held by consumers.

*Apparent domestic consumption of refined new copper in 1910 and 1911, in pounds.*

| | 1910 | 1911 |
|---|---|---|
| Total refinery output of new copper | 1,422,039,135 | 1,433,875,026 |
| Stock at beginning of year | 141,486,244 | 122,803,656 |
| Total available supply | 1,563,525,379 | 1,556,678,682 |
| Refined copper exported | [a] 708,316,543 | [a] 786,553,208 |
| Stocks at end of year | 122,803,656 | 88,372,195 |
| Total withdrawn from supply | 831,120,199 | 874,925,403 |
| Apparent consumption | 732,405,180 | 681,753,279 |

[a] Exports of pigs, bars, ingots, plates, etc., reported by the Bureau of Statistics.

If to the 681,700,000 pounds of new refined copper is added the 214,207,000 pounds of secondary copper and copper in alloys produced during the year, it is found that a total of 895,900,000 pounds of new and old copper was available for domestic consumption.

The following table shows the monthly deliveries of copper for domestic consumption and export as reported by the Copper Producers' Association:

*Monthly deliveries of copper for domestic consumption and for export in 1911 as reported by the Copper Producers' Association, in pounds.*

| Month. | Domestic consumption. | Export. | Total. |
|---|---|---|---|
| January | 42,075,567 | 53,208,739 | 95,287,296 |
| February | 50,516,996 | 45,111,019 | 95,630,017 |
| March | 66,080,789 | 59,081,127 | 125,161,916 |
| April | 52,407,650 | 62,129,599 | 114,537,249 |
| May | 64,543,963 | 61,978,557 | 126,522,520 |
| June | 61,655,561 | 71,460,519 | 133,116,080 |
| July | 56,982,582 | 74,886,658 | 131,863,240 |
| August | 59,935,364 | 69,855,660 | 129,791,624 |
| September | 57,311,584 | 50,824,011 | 108,135,595 |
| October | 64,068,307 | 60,084,349 | 124,152,656 |
| November | 68,039,776 | 67,049,279 | 135,089,055 |
| December | 65,988,474 | 79,238,716 | 145,227,190 |
| Total | 709,611,605 | 754,902,233 | 1,464,513,838 |

It may be noted that the difference in domestic deliveries as shown by the reports of the Copper Producers' Association and those calculated above is due to the fact that the figures of export as reported by the Bureau of Statistics and by the Producers' Association do not agree exactly. The cause of this difference is stated under the discussion of exports.

## USES.

No systematic attempt has been made to ascertain the proportion of the copper output of 1911 used in different industries, as electric transmission, brass manufacture, casting, etc. Some idea of the quantities entering the different industries can be gained from the forms in which the output of the refineries was cast. The following table shows the approximate quantity of copper cast in the different forms during 1911 as reported by the refining companies. It will be noted that the total does not equal the refinery output of copper for 1911:

*Forms in which copper was cast in 1911, in pounds.*

| Form. | Total. | Percentage. |
|---|---|---|
| Wire bars | 731,029,349 | 50 |
| Ingots and ingot bars | 409,786,682 | 29 |
| Cakes | 143,716,125 | 10 |
| Cathodes | 135,499,770 | 9 |
| Other forms | 25,774,328 | 2 |
| Total | 1,445,806,254 | 100 |

It may be assumed that a large portion of the 50 per cent cast as wire bars was used for electrical purposes and that the 10 per cent cast as cakes was used largely for rolling. The other forms are less easily classified. The 9 per cent cast as cathodes, together with a portion of the ingots, probably entered the brass industry, and a large quantity of copper ingots was used in casting. The refinery output for 1910 was cast as follows: Wire bars, 50 per cent; ingots, 31 per cent; cakes, 10 per cent; cathodes, 7 per cent; other forms, 2 per cent.

## PRICES.

The average yearly quoted price of electrolytic copper at New York in 1911 was about 12.5 cents per pound; in 1910 the price was 12.738 cents per pound. The average monthly prices for electrolytic copper in 1910 and 1911 are given in the following table:

*Monthly prices per pound of copper in 1910 and 1911, in cents.*

| Month. | Price of electrolytic copper, in cents. | |
|---|---|---|
| | 1910 | 1911 |
| January | 13.620 | 12.53 |
| February | 13.332 | 12.48 |
| March | 13.255 | 12.31 |
| April | 12.733 | 12.155 |
| May | 12.350 | 12.13 |
| June | 12.404 | 12.55 |
| July | 12.215 | 12.625 |
| August | 12.490 | 12.575 |
| September | 12.379 | 12.39 |
| October | 12.553 | 12.36 |
| November | 12.742 | 12.77 |
| December | 12.581 | 13.71 |
| Average | 12.738 | 12.55 |

The average yearly price of Lake copper was 12.71 cents. These quoted prices are the basis on which much of the copper is sold by the mines and are used by the United States Geological Survey in calculating the value of both mine and smelter output. It is well known, however, that this average yearly price only approximates the actual average price received for copper sold during the year.

The actual average price received by Michigan companies was 12.773 cents per pound.

## WORLD'S PRODUCTION.

The smelter production of copper in the world was 1,958,201,285 pounds in 1911, as compared with 1,903,297,003 pounds in 1910. In 1911 the smelter output of the United States was 56 per cent of the world's production, as compared with 56.75 per cent in 1910, with 58 per cent in 1909, and with 56.5 per cent in 1908.

The following table shows the world's production, by countries. The figures are those compiled by Henry R. Merton & Co. (Ltd.), of London, reduced to pounds, except that the official figures for the production of the United States and Canada are inserted.

*World's production (smelter output) of copper in 1910 and 1911, in pounds.*

(Copper extracted from ore or contained in the ore produced.)

| Countries. | 1910 | 1911 |
|---|---|---|
| Germany | 55,335,460 | 49,162,580 |
| England | 1,102,300 | 1,102,300 |
| Italy | 7,275,180 | 5,731,960 |
| Norway | 23,368,760 | 20,943,700 |
| Austria | 4,850,120 | 5,511,500 |
| Russia | 50,044,420 | 57,319,600 |
| Sweden | 4,409,200 | 4,409,200 |
| Spain and Portugal | 112,655,060 | 116,843,800 |
| Turkey | 1,322,760 | 2,204,600 |
| Hungary | 220,460 | 220,460 |
| Servia | 10,802,540 | 19,400,480 |
| Total Europe | 271,386,260 | 282,850,180 |
| Canada | 56,598,074 | 55,848,665 |
| Mexico | 131,614,620 | 125,000,820 |
| Newfoundland | 2,425,060 | 2,645,520 |
| United States | 1,080,159,509 | 1,097,232,700 |
| Total North America | 1,270,797,263 | 1,280,727,705 |
| Argentina | 661,380 | 2,204,600 |
| Bolivia | 5,511,500 | 3,968,280 |
| Chile | 78,924,680 | 66,358,460 |
| Peru | 41,005,560 | 57,099,140 |
| Cuba | 7,716,100 | 9,920,700 |
| Total Central and South America | 133,819,220 | 139,551,180 |
| Cape Colony | 9,920,700 | 15,652,660 |
| Namaqualand | 5,511,500 | ..... |
| Other Africa | 18,518,640 | 22,486,920 |
| Total Africa | 33,950,840 | 38,139,580 |
| Japan | 102,954,820 | 123,237,140 |
| Australia | 90,388,600 | 93,695,500 |
| Grand total | 1,903,297,003 | 1,958,201,285 |

# LEAD.

By C. E. Siebenthal.

## INTRODUCTION.

An estimate of the production of refined lead in 1911 was given out in the form of a press bulletin on January 2, 1912. This was based on reports from every smelter, giving the actual production for the first 10 or 11 months, with estimates for the remainder of the year. The total thus obtained was one-ninth of 1 per cent, or 544 tons, more than the final figures of production. The complete figures of production of consumption of primary [1] refined lead and of imports and exports of lead in ore and bullion were given in the advance statement of lead production, which was published March 23, 1912. The present report contains, in addition, tables and curves showing the production, consumption, imports, exports, and prices for a period of years, a comparison of the mine and the smelter production of lead by States, a list of lead smelters, and a summary of metallurgical advance in 1911.

The statistics of production of lead in this country in 1911 have been compiled by the United States Geological Survey from confidential reports by each lead-smelting company in operation during the year. The statistics of the recovery of secondary lead were also collected by the United States Geological Survey. The statistics of domestic consumption are taken in part from the smelter returns and in part from the records of the Bureau of Statistics of the Department of Commerce and Labor, and the tables for foreign production and consumption were compiled from the sources indicated.

## STATE OF LEAD INDUSTRY IN 1911.

The lead-smelting industry in 1911 had on the whole a busy year, marked by the construction of one new smelter and the beginning of construction of a new refinery. The total production of primary lead from all sources, domestic and foreign, made a gain of 5 per cent over the production of 1910, a gain made wholly by domestic lead, the output of foreign lead smelted or refined in this country having fallen away 14,419 tons. Missouri made individually the largest gain and produced very nearly 45 per cent of the domestic pig lead. Idaho made nearly as great a gain as Missouri, and among the smaller pro-

[1] By primary lead is meant lead which has been produced directly from ore. This term is used for purposes of distinction from secondary lead, which is obtained by refining skimmings, drosses, old metals, etc., figures for the production of which are given on a later page. Wherever in this report the word "lead" is used without qualification primary lead is to be understood.

ducers Arizona quadrupled its 1910 output. Colorado and Utah both sustained losses in lead output. The soft-lead production of the United States made further gains on the argentiferous-lead output, being equal to more than 95 per cent of the desilverized lead produced in 1911. A year ago it seemed that the production of soft pig lead must soon overtake and pass the output of desilverized lead, but the great gain made by Idaho in 1911 and the installation of flotation concentration and electrostatic separation machinery in the Western States, together with the construction of a new smelter, thus insuring higher recovery, greater competition, and better prices, now make it uncertain that argentiferous-lead production will not keep in the lead.

As has been true for several years, certain important producers were unwilling to report stocks of lead on hand at the close of the year, so that it is not possible to state accurately the deliveries to consumption. As the next best thing, the lead available for consumption is calculated from the domestic production, together with imports, exports, and stocks of foreign lead in bonded warehouse.

A feature of the year was the great reduction of stocks of foreign lead in bonded warehouse, which decreased from 35,972 short tons to 4,481 tons.

## PRODUCTION.

### PRODUCTION, 1825–1911.

The production of lead in the United States since 1825 from domestic ores and from foreign ores and base bullion is shown in the table following. For the early years, in the absence of official records, the figures have been compiled from the best available sources. The figures for the period from 1825 to 1853 are those published by Whitney; those for the later years were collected by E. A. Caswell. Totals for 1882 were compiled from statistics gathered by the Census Bureau. Since 1882 the figures have been annually collected by the United States Geological Survey.

According to Hahn,[1] argentiferous-lead ore was smelted in Montana and Nevada as early as 1866–67, but for the silver only, as the value of the lead would not pay transportation charges to market. With the completion of the Union Pacific Railroad in 1869 and the development of the mines at Eureka, Nev., the production of lead bullion began. The first figures of this production which are available are for 1873. It is evident from the totals for 1871 and 1872 that not much bullion was produced before 1873. Estimates have been made for these years, as well as for 1874, in order to arrive at totals for the different classes of lead. Foreign bullion, principally from Mexico, began in 1891 to be imported into this country for refining, but before 1906 the annual quantities so imported were not distinguished in the statistical record of general imports from the lead imported in ore. Since the soft lead is all domestic, the desilverized lead of domestic origin can be readily found by subtracting the total lead of foreign origin from the total desilverized-lead production of that year, or by subtracting the soft lead from the total domestic lead of that year. Prior to 1906 the total production of antimonial lead was included in the production of refined, desilverized lead, but since that date it has been excluded.

[1] Mineral Resources U. S. for 1882, U. S. Geol. Survey, 1883, p. 324.

*Production of refined lead in the United States, 1825–1911, in short tons.*

| Year. | Antimonial lead.[a] | Desilverized lead.[b] | Soft lead.[c] | Total production.[b] | From domestic ores and base bullion.[b] | From foreign ores.[d] | From foreign base bullion.[e] |
|---|---|---|---|---|---|---|---|
| 1825–1868 | ..... | ..... | 676,200 | 676,200 | 676,200 | ..... | ..... |
| 1869 | ..... | ..... | 17,500 | 17,500 | 17,500 | ..... | ..... |
| 1870 | ..... | ..... | 17,830 | 17,830 | 17,830 | ..... | ..... |
| 1871 | ..... | f1,000 | f19,000 | 20,000 | 20,000 | ..... | ..... |
| 1872 | ..... | f5,380 | f20,500 | 25,880 | 25,880 | ..... | ..... |
| 1873 | ..... | 20,159 | 22,381 | 42,540 | 42,540 | ..... | ..... |
| 1874 | ..... | f28,524 | f23,556 | 52,080 | 52,080 | ..... | ..... |
| 1875 | ..... | 34,909 | 24,731 | 59,640 | 59,640 | ..... | ..... |
| 1876 | ..... | 37,649 | 26,421 | 64,070 | 64,070 | ..... | ..... |
| 1877 | ..... | 50,748 | 31,152 | 81,900 | 81,900 | ..... | ..... |
| 1878 | ..... | 64,290 | 26,770 | 91,060 | 91,060 | ..... | ..... |
| 1879 | ..... | 64,650 | 28,130 | 92,780 | 92,780 | ..... | ..... |
| 1880 | ..... | 70,135 | 27,690 | 97,825 | 97,825 | ..... | ..... |
| 1881 | ..... | 86,315 | 30,770 | 117,085 | 117,085 | ..... | ..... |
| 1882 | ..... | 103,875 | 29,015 | 132,890 | 132,890 | ..... | ..... |
| 1883 | ..... | 122,157 | 21,800 | 143,957 | 143,957 | ..... | ..... |
| 1884 | ..... | 119,965 | 19,932 | 139,897 | 139,897 | ..... | ..... |
| 1885 | ..... | 107,437 | 21,975 | 129,412 | 129,412 | ..... | ..... |
| 1886 | ..... | 114,829 | 20,800 | 135,629 | 130,629 | 5,000 | ..... |
| 1887 | ..... | 135,552 | 25,148 | 160,700 | 145,700 | 15,000 | ..... |
| 1888 | ..... | 151,465 | 29,090 | 180,555 | 151,919 | 28,636 | ..... |
| 1889 | ..... | 153,709 | 29,258 | 182,967 | 156,397 | 26,570 | ..... |
| 1890 | ..... | 130,403 | 31,351 | 161,754 | 143,630 | 18,124 | ..... |
| 1891 | a4,043 | 171,009 | 31,397 | 202,406 | 178,554 | 23,852 | ..... |
| 1892 | a5,039 | 181,584 | 31,678 | 213,262 | 173,305 | 39,957 | ..... |
| 1893 | a5,013 | 196,820 | 32,513 | 229,333 | 163,982 | 65,351 | ..... |
| 1894 | ..... | 181,404 | 37,686 | 219,090 | 159,351 | 59,739 | ..... |
| 1895 | ..... | 201,992 | 39,890 | 241,882 | 165,709 | 76,173 | ..... |
| 1896 | a7,507 | 221,457 | 43,537 | 264,994 | 187,256 | 77,738 | ..... |
| 1897 | a8,867 | 247,483 | 43,553 | 291,036 | 207,365 | 83,671 | ..... |
| 1898 | a8,473 | 267,842 | 42,779 | 310,621 | 210,676 | 99,945 | ..... |
| 1899 | a6,345 | 263,826 | 40,566 | 304,392 | 208,466 | 95,926 | ..... |
| 1900 | a9,906 | 329,658 | 48,021 | 377,679 | 270,824 | 106,855 | ..... |
| 1901 | a10,656 | 323,790 | 57,898 | 381,688 | 269,266 | 112,422 | ..... |
| 1902 | a9,169 | 303,011 | 74,050 | 377,061 | 276,455 | 100,606 | ..... |
| 1903 | a9,579 | 295,074 | 83,444 | 378,518 | 290,194 | 88,324 | ..... |
| 1904 | a11,001 | 317,498 | 86,955 | 404,453 | 308,603 | 95,850 | ..... |
| 1905 | a10,995 | 313,847 | 85,455 | 399,302 | 318,509 | 80,793 | ..... |
| 1906 | 10,546 | 313,886 | 90,860 | 404,746 | 336,200 | 28,803 | 39,743 |
| 1907 | 9,910 | 314,241 | 99,948 | 414,189 | 337,340 | 43,925 | 32,924 |
| 1908 | 13,629 | 295,420 | 101,013 | 396,433 | 298,672 | 40,272 | 57,489 |
| 1909 | 12,896 | 329,310 | 118,802 | 448,112 | 345,255 | 74,035 | 28,822 |
| 1910 | 14,069 | 329,062 | 141,318 | 470,380 | 361,827 | 76,905 | 31,648 |
| 1911 | 14,078 | 331,029 | 155,947 | 486,976 | 392,842 | 64,991 | 29,143 |
| Total | ..... | 7,332,394 | 2,708,310 | 10,040,704 | 8,191,472 | 1,849,232 | |

a Included also under desilverized lead and total production prior to 1906.
b Including also antimonial lead, except for 1906–1911, inclusive.
c Desilverized soft lead is excluded.
d Including also lead from foreign base bullion for 1891–1905, inclusive.
e Included in lead from foreign ore prior to 1906.
f Estimated.

## PRODUCTION CURVES.

The curves in figure 5 show graphically the total domestic lead production from 1830 to the present, the production of soft lead from 1830 to 1910, and the production of desilverized lead since the beginning of that industry. In order to obtain a curve for the total production of soft lead, both plain and desilverized, the quantities of soft lead annually desilverized have been added to the output of the soft-lead smelters. Since there is no record of the desilverized soft lead prior to 1894, a portion of the curve representing the total production of soft lead is hypothetical, as indicated by a broken line. The curve representing the production of desilverized lead was obtained by taking the difference between the plain soft-lead curve and the curve of total lead production.

Perhaps the most striking fact brought out by the curve is that practically all the gain in domestic lead output in the last six years has been made in the production of soft lead. This is the graphic representation of the fact brought out by the production tables that the western lead-producing States have remained practically stationary in output in recent years, while the southeast Missouri lead region has made great gains.

These curves have been derived by taking nine-year averages. That is, each point in the curve representing a year is the average of that

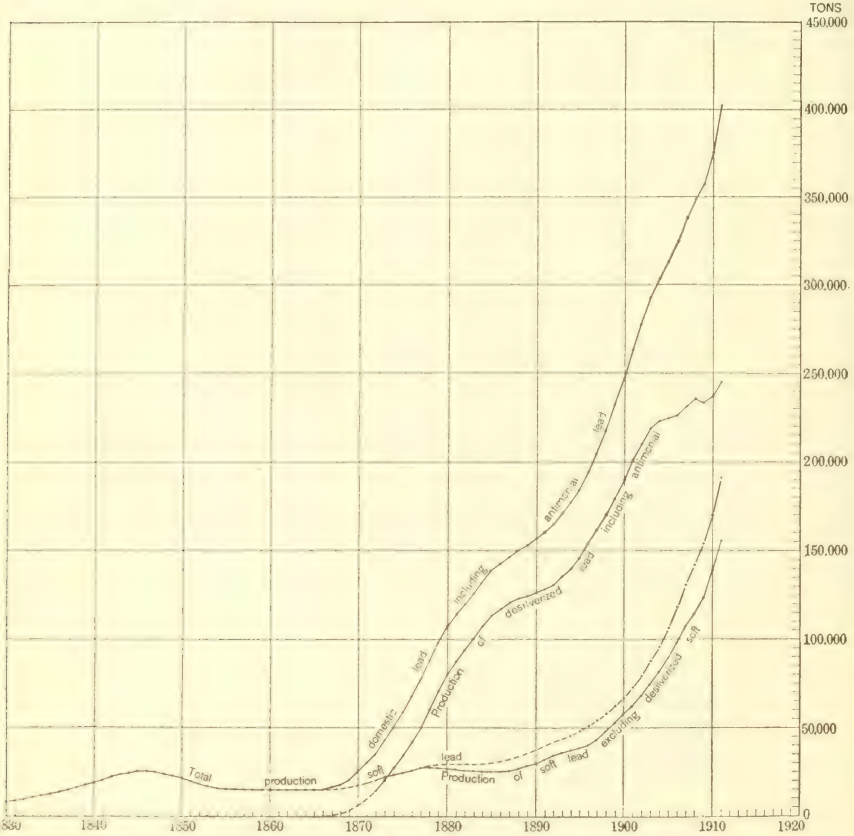



FIGURE 5.—Diagram showing domestic lead production in the United States, 1830–1911.

year as well as of the four years preceding and of the four years following, except near the ends of the curve, where the number of adjacent years included in the average is necessarily fewer. This method practically eliminates the yearly vicissitudes of production and yields a natural curve of the periodic trend of the industry.

## PRODUCTION BY STATES.

The following table showing the production of lead by States is taken, with the exceptions indicated, from two sources which in themselves involve somewhat different methods of compilation. The figures for years prior to 1894 are from the trade statistics of E. A.

Caswell and are in terms of refined lead. Compiled from reports by smelters and transportation companies, they probably represent to a certain extent the locality where smelted rather than that of the origin of the ore, but for the period involved these two items must have nearly coincided. For the years 1894 to 1905, inclusive, the figures have been collected by the United States Geological Survey. They were compiled from smelter reports and it should be noted that they represent the content of the ores and not the actual recovery, which is the quantity available for consumption. The latter quantity, termed "merchant lead," may be estimated from the figures of lead content by deducting therefrom a proper allowance for losses in smelting, desilverizing, and refining.

*Production of lead by States, 1873–1905, in short tons.*

| Year. | Argentiferous lead. | | | | | | | | | | Mississippi Valley soft lead. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Colorado. | Utah. | Montana. | Idaho. | California. | Arizona. | New Mexico. | Washington. | Nevada. | Other Western States. | Missouri-Kansas. | Southeast Missouri. | Wisconsin-Illinois. |
| 1873 | 56 | | | | | | | | | | 15,045 | | 7,336 |
| 1874 | 312 | | | | | | | | | | | | 5,400 |
| 1875 | 818 | | | | | | | | | | 19,099 | | 5,600 |
| 1876 | 667 | | | | | | | | | | 19,225 | | 7,196 |
| 1877 | 897 | 24,194 | 2,912 | | 3,918 | | | | 19,724 | (a) | 15,422 | 9,312 | 6,418 |
| 1878 | 5,824 | 21,627 | 456 | | 4,320 | | | | 31,063 | (a) | 11,761 | 10,517 | 4,492 |
| 1879 | 22,783 | 14,370 | 2,431 | | 2,251 | | | | 22,805 | (a) | 14,182 | 11,158 | 2,800 |
| 1880 | 34,240 | 15,214 | 1,922 | | 2,100 | | | | 16,659 | (a) | 15,780 | 7,970 | 3,940 |
| 1881 | 42,516 | 23,973 | 3,360 | | 3,340 | | | | 12,826 | (a) | | 30,770 | |
| 1882 | 60,988 | 29,947 | | | | | | | 8,590 | 3,700 | | 29,015 | |
| 1883 | 70,800 | 33,330 | | | | | | | 5,775 | 15,840 | | 21,600 | |
| 1884 | 72,600 | 30,432 | 7,470 | | | | | | | 14,718 | | 18,140 | |
| 1885 | 53,500 | 29,160 | 10,993 | | | | | | | 20,600 | | 21,265 | |
| 1886 | 48,480 | 24,332 | 12,632 | | | | | | | 19,500 | | 22,460 | |
| 1887 | 55,722 | 22,900 | 16,000 | | | | | | | 22,400 | | 27,958 | |
| 1888 | 56,916 | 22,283 | 31,400 | | | | | | | 15,201 | | 31,252 | |
| 1889 | 54,288 | 31,180 | 28,400 | | | | | | | 13,709 | | 27,400 | |
| 1890 | 51,450 | 34,132 | 18,300 | | | | | | | 10,664 | | 33,840 | |
| 1891 | 58,950 | 43,360 | 28,000 | | | | | | | 20,168 | | 29,763 | |
| 1892 | 48,400 | 45,553 | 32,600 | | | | | | | 21,527 | | 32,895 | |
| 1893 | 46,800 | 35,043 | 20,045 | | | | | | | 24,900 | | 32,859 | |
| 1894 | 50,613 | 23,190 | 9,637 | 33,308 | 478 | 1,480 | 2,973 | | 2,254 | 150 | | 46,300 | |
| 1895 | 46,984 | 31,305 | 9,802 | 31,638 | 949 | 2,053 | 3,040 | | 2,583 | 381 | | 53,596 | |
| 1896 | 44,803 | 35,578 | 11,070 | 46,662 | 691 | 1,165 | 3,461 | | 1,173 | 1,006 | | 51,887 | |
| 1897 | 40,576 | 40,537 | 12,930 | 58,627 | 383 | 2,184 | 9,123 | | 959 | 638 | | 56,542 | |
| 1898 | 57,352 | 39,299 | 10,745 | 59,142 | 482 | 2,224 | 5,797 | | 4,714 | 1,349 | | 54,469 | |
| 1899 | 70,308 | 29,987 | 10,227 | 52,154 | 487 | 3,377 | 4,856 | | 3,388 | 862 | | 54,444 | |
| 1900 | 82,137 | 48,044 | | 85,444 | 520 | | | | | | | | |
| 1901 | 73,265 | 49,870 | 5,791 | 79,654 | 381 | 4,045 | 1,124 | | 1,873 | 1,029 | | 67,172 | |
| 1902 | 51,833 | 53,914 | 4,438 | 84,742 | 175 | 599 | 741 | 1,457 | 1,269 | 2,184 | | 79,445 | |
| 1903 | 45,554 | 51,129 | 3,303 | 99,590 | 55 | 1,493 | 613 | 538 | 2,237 | 1,765 | | 86,597 | |
| 1904 | 51,884 | 56,470 | 3,635 | 108,854 | 163 | 1,499 | 1,363 | 622 | 1,873 | 41 | | 92,275 | |
| 1905 | 56,638 | 44,996 | 2,207 | 99,027 | 116 | 2,091 | 1,232 | 56 | 2,206 | 101 | | 104,058 | |

a Included under Montana.

The closer distribution of the lead production among the States from which the ore was derived, which was begun in 1906, has necessitated the separate table which follows. The product of refined lead can with difficulty be apportioned according to sources of ore, owing to the fact that lead refiners treat smelted products whose origin may, as in custom refining, be unknown to them, the identity of the ore and thus its original source being preserved only as far as the smelter. Accordingly, this table, showing sources of lead smelted or refined in the United States, is based as far as possible on smelter figures. It includes "pig lead" reported by all known smelters running on Mis-

sissippi Valley or southern lead ores, and "lead" produced at all other lead smelters in this country. The greater part of the product reported by smelters operated in conjunction with refineries is in terms of refined lead. A like part of the antimonial lead product is thus eliminated from the "lead" produced and appears only in the figures of production of antimonial lead. No lead ore from the United States was treated elsewhere during the period covered by the table.

*Sources of primary lead smelted or refined in the United States, 1906–1911, in short tons.*

| Source of ore. | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 | |
|---|---|---|---|---|---|---|---|
| | Quantity. | Quantity. | Quantity. | Quantity. | Quantity. | Quantity. | Percentage of total. |
| Domestic ore: | | | | | | | |
| Alaska | 8 | ..... | 3 | 60 | 60 | 50 | 0.01 |
| Arizona | 2,884 | 2,340 | 1,464 | 1,465 | 858 | 3,450 | .85 |
| Arkansas | ..... | 15 | ..... | 14 | ..... | 15 | ..... |
| California | 432 | 854 | 515 | 937 | 1,160 | 615 | .15 |
| Colorado | 50,497 | 48,876 | 28,728 | 29,326 | 35,685 | 30,621 | 7.54 |
| Georgia | ..... | 2 | ..... | ..... | ..... | ..... | ..... |
| Idaho | 117,117 | 112,569 | 98,464 | 97,183 | 99,924 | 117,159 | 28.85 |
| Illinois | 572 | 498 | 363 | 273 | 262 | 308 | .08 |
| Iowa | 270 | 225 | 110 | 15 | ..... | ..... | ..... |
| Kansas | 1,932 | 1,798 | 2,293 | 2,764 | 1,308 | 2,522 | .62 |
| Kentucky | 44 | 75 | ..... | ..... | 50 | ..... | ..... |
| Missouri | 111,075 | 122,856 | 122,451 | 142,650 | 161,659 | 182,207 | 44.86 |
| Montana | 2,485 | 2,035 | 2,320 | 1,376 | 1,790 | 2,499 | .62 |
| Nevada | 1,669 | 3,380 | 3,796 | 4,698 | 2,195 | 1,083 | .27 |
| New Hampshire | ..... | ..... | ..... | 5 | ..... | ..... | ..... |
| New Mexico | 640 | 1,927 | 586 | 1,275 | 1,731 | 1,381 | .34 |
| Oklahoma | ..... | 404 | 1,409 | 2,268 | 1,805 | 1,925 | .47 |
| Oregon | ..... | ..... | 7 | 6 | ..... | 11 | ..... |
| South Dakota | ..... | ..... | 13 | ..... | 7 | 33 | .01 |
| Tennessee | 11 | 16 | ..... | ..... | ..... | ..... | ..... |
| Texas | 25 | 10 | 42 | 42 | 33 | 57 | .01 |
| Utah | 56,260 | 61,699 | 42,455 | 64,534 | 57,081 | 55,198 | 13.59 |
| Virginia | ..... | 82 | 13 | ..... | 87 | 400 | .10 |
| Washington | 46 | 281 | 391 | 115 | 311 | 601 | .15 |
| Wisconsin | 1,753 | 3,551 | 4,013 | 3,238 | 3,884 | 3,967 | .98 |
| Philippine Isl'ds | ..... | ..... | ..... | ..... | ..... | 5 | ..... |
| Undistributed | 380 | 355 | 36 | 303 | 288 | 50 | .01 |
| Zinc residues | 2,053 | 1,318 | 1,290 | 1,641 | 2,049 | 1,991 | .49 |
| Total from domestic ore | 350,153 | 365,166 | 310,762 | 354,188 | 372,227 | 406,148 | 100.00 |
| Foreign ore: | | | | | | | |
| Africa | ..... | 323 | ..... | 3,227 | 3,499 | 509 | ..... |
| Canada | 7,238 | 5,793 | 341 | 71 | 44 | 119 | ..... |
| Central America | 112 | ..... | 12 | 25 | 7 | 27 | ..... |
| Mexico | 21,435 | 36,749 | 38,729 | 69,100 | 70,159 | 61,978 | ..... |
| South America | ..... | 911 | 1,186 | 1,574 | 3,168 | 2,339 | ..... |
| Other foreign | 18 | 149 | 4 | 38 | 28 | 19 | ..... |
| Foreign base bullion: | | | | | | | |
| Canada | ..... | ..... | ..... | 1,816 | ..... | ..... | ..... |
| Mexico | 39,743 | 32,924 | 57,489 | 27,006 | 31,648 | 29,143 | ..... |
| Total from foreign ore and base bullion. | 68,546 | 76,849 | 97,761 | 102,857 | 108,553 | 94,134 | ..... |
| Grand total, derived from all sources | 418,699 | 442,015 | 408,523 | 457,045 | 480,780 | 500,282 | ..... |

## SOFT LEAD.

The lead ores of the Mississippi Valley are almost free from silver, and the lead produced from them is known as "soft lead." A little lead ore derived from Washington and other Western States is also

of this character. All but one of the smelters running exclusively on these soft-lead ores do not desilverize their product. Their output is shown in the "soft lead" column of the general table of refined lead production for 1825–1911, which is given on a preceding page. However, considerable quantities of the soft lead ores have been annually smelted by the silver-lead smelters, and, in addition, since 1904 one of the Mississippi Valley smelters has regularly desilverized its product. This desilverized soft lead, for the years prior to 1906, has not been kept separate from the lead produced from silver-lead ores, though the lead content of the soft-lead ores so smelted has been recorded since 1894. Since 1906 the quantity of soft lead produced by each State has been recorded, as shown in the tables below. In the table immediately following, the output of the soft-lead smelters is given in the first column, and the lead content of soft-lead ores smelted and desilverized is given in the second column. For the years 1904 and 1905 a portion of the quantity given in the second column represents lead content of ore, and a portion is refined lead. From 1906 to the present the only quantity given is that of refined lead.

In order to give a fair notion of the annual quantity of refined pig lead recovered from soft-lead ores, the lead recovered from such ores by the silver-lead smelters has been estimated at the rate of recovery used in the official reports for those years. Even so, the figures do not give the total quantity of lead recovered from soft-lead ores. To give the total recovered soft lead there must be taken into account the lead recovered in the form of pigments, as these are made from soft-lead ores. On this basis the soft lead recovered in 1911 constituted 48 per cent of the total domestic lead production, as compared with 47 per cent in 1910.

*Production of soft lead in the United States, 1894–1911, in short tons.*

| Year. | Undesilverized. | Desilverized. | | Total soft lead. |
|---|---|---|---|---|
| | | Lead contents of ore. | Recovered lead. | |
| 1894 | 37,686 | [a] 8,614 | [b] 8,097 | [b] 45,783 |
| 1895 | 39,890 | [a] 13,706 | [b] 12,884 | [b] 52,774 |
| 1896 | 43,537 | [a] 8,350 | [b] 7,849 | [b] 51,386 |
| 1897 | 43,553 | [a] 12,989 | [b] 12,210 | [b] 55,763 |
| 1898 | 42,779 | [a] 11,688 | [b] 10,987 | [b] 53,766 |
| 1899 | 40,566 | [a] 13,878 | [b] 13,045 | [b] 53,611 |
| 1900 | 48,021 | [a] 11,500 | [b] 10,810 | [b] 58,831 |
| 1901 | 57,898 | [a] 9,274 | [b] 8,718 | [b] 66,616 |
| 1902 | 74,050 | [a] 5,395 | [b] 5,071 | [b] 79,121 |
| 1903 | 83,444 | [a] 3,153 | [b] 2,961 | [b] 86,408 |
| 1904 | 89,169 | [c] 5,320 | [b] 5,165 | [b] 94,334 |
| 1905 | 85,455 | [c] 18,603 | [b] 18,556 | [b] 104,011 |
| 1906 | 90,860 | ..... | 25,000 | 115,860 |
| 1907 | 99,948 | ..... | 29,809 | 129,757 |
| 1908 | 101,013 | ..... | 29,869 | 130,882 |
| 1909 | 118,802 | ..... | 32,420 | 151,222 |
| 1910 | 141,318 | ..... | 27,926 | 169,244 |
| 1911 | 155,947 | ..... | 35,672 | 191,619 |

[a] Lead content of ores smelted and desilverized.
[b] Estimated recovery of lead from lead content of ore.
[c] In part lead content of ores, in part refined lead.

The table below shows the production of soft pig lead, by States, for the period 1906–1911, which is as far back as the records of the individual production of the Mississippi Valley States are available. These figures include both plain and desilverized soft lead, but do not include the lead content of pigments.

*Production of soft pig lead in the United States in 1906–1911, by States, in short tons.*

| Source of ore. | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|---|
| Arkansas | ..... | 15 | ..... | 14 | ..... | 15 |
| Illinois | 572 | 498 | 363 | 273 | 262 | 308 |
| Iowa | 270 | 225 | 110 | 15 | ..... | ..... |
| Kansas | 1,932 | 1,798 | 2,293 | 2,764 | 1,308 | 2,522 |
| Kentucky | 44 | 75 | ..... | ..... | 50 | ..... |
| Missouri | 111,075 | 122,856 | 122,451 | 142,650 | 161,659 | 182,207 |
| Oklahoma | ..... | 404 | 1,409 | 2,268 | 1,805 | 1,925 |
| Tennessee | 11 | 16 | ..... | ..... | ..... | ..... |
| Virginia | ..... | 82 | 13 | ..... | 87 | 400 |
| Washington | 19 | 87 | 230 | ..... | 189 | 275 |
| Wisconsin | 1,753 | 3,551 | 4,013 | 3,238 | 3,884 | 3,967 |
| Undistributed | 184 | 150 | ..... | ..... | ..... | ..... |
| Total | 115,860 | 129,757 | 130,882 | 151,222 | 169,244 | 191,619 |

## ANTIMONIAL LEAD.

The production of antimonial lead from ores derived from all sources, as reported by all desilverizers operating in this country, is shown in the following table:

*Production of antimonial lead in the United States from 1891 to 1911, in short tons.*

| | | | |
|---|---|---|---|
| 1891 | 4,043 | 1902 | 9,169 |
| 1892 | 5,039 | 1903 | 9,579 |
| 1893 | 5,013 | 1904 | 11,001 |
| 1894 | ..... | 1905 | 10,995 |
| 1895 | ..... | 1906 | 10,546 |
| 1896 | 7,507 | 1907 | 9,910 |
| 1897 | 8,867 | 1908 | 13,629 |
| 1898 | 8,473 | 1909 | 12,896 |
| 1899 | 6,345 | 1910 | 14,069 |
| 1900 | 9,906 | 1911 | 14,078 |
| 1901 | 10,656 | | |

*Production of antimonial lead in the United States, 1907–1911, in short tons.*

| Year. | From domestic ore. | From foreign ore. | Total. | Value. | Antimony content. | Lead content. |
|---|---|---|---|---|---|---|
| 1907 | ..... | ..... | 9,910 | $1,322,985 | 1,561 | 8,349 |
| 1908 | ..... | ..... | 13,629 | 1,264,771 | 2,440 | 11,189 |
| 1909 | 8,889 | 4,007 | 12,896 | 1,231,019 | 2,360 | 10,536 |
| 1910 | 10,140 | 3,929 | 14,069 | 1,338,090 | 2,229 | 11,840 |
| 1911 | 9,636 | 4,442 | 14,078 | 1,380,556 | 2,254 | 11,824 |
| Average composition, by percentage | ..... | ..... | ..... | ..... | 16.8 | 83.2 |

For further details of the production and consumption of antimony in the United States, the reader is referred to the chapter on antimony in this volume.

## LEAD PIGMENTS.

In addition to the leaded zinc oxide and zinc-lead oxide pigments, which are noted more particularly in connection with the production of zinc pigments, there are two lead pigments which are produced directly from ore, namely, sublimed white lead and sublimed blue lead. Sublimed white lead consists of lead sulphate 75 per cent, lead oxide 20 per cent, and zinc oxide 5 per cent. Sublimed blue lead consists of lead sulphate 50 to 53 per cent, lead oxide 41 to 38 per cent, with small proportions of lead sulphide, lead sulphite, and zinc oxide. Zinc-lead oxide contains from 46 to 50 per cent of lead sulphate, from 52 to 46 per cent of zinc oxide, and a small amount of zinc sulphate. Leaded zinc oxide may vary from 4 to 20 per cent in lead sulphate, the remainder being zinc oxide, with a small portion of zinc sulphate.

The total lead content of the 1911 production from domestic ores of the above-mentioned pigments was 7,678 short tons, as compared with 7,603 tons in 1910, with 7,292 tons in 1909, with 7,377 tons in 1908, and with 6,574 tons in 1907.

The St. Louis Smelting & Refining Co. in 1909 completed as an adjunct to the lead smelter at Collinsville, Ill., a plant for the manufacture of sublimed lead pigments directly from ore. The pigment works were closed in 1910 by an injunction secured by the Picher Lead Co. on the ground of infringement of patents controlled by the latter company. The case is still in litigation.

## SECONDARY LEAD.

Important sources of lead are skimmings, drosses, old metal, and alloys, as babbitt, solder, and type metal. The recovery of lead by refining these materials constitutes an integral portion of the lead industry. This business is mostly carried on at small refineries scattered over the United States, but the large smelters and refineries working primary lead frequently find it advantageous to incorporate material from secondary sources. In such cases it has been noted on the reports of the smelters to the Survey, and to that extent the production of secondary lead has always been taken into account. Since 1907, however, statistics have been collected from the secondary refineries, for the first two years by the writer, and for the last two years by J. P. Dunlop, of the United States Geological Survey. In 1907 and 1908 reports were obtained from the larger plants only, but in 1909 the scope of the canvass was greatly enlarged and the number of firms reporting was increased from 44 to 100, with the result that the figures of production for later years show a great increase. The product of such secondary refineries is of two classes, pig lead and lead in alloys. In the latter case the lead may have been recovered in the form of pig lead and alloyed at the refinery, or it may have been refined as an alloy, being brought to the desired composition by addition of the requisite metal.

*Production of secondary lead in the United States in 1907–1911, in short tons.*

| | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|
| Pig lead | 9,990 | 7,990 | 17,822 | 29,384 | 27,359 |
| Lead in alloys | 15,508 | 10,543 | 23,327 | 25,939 | 26,895 |
| Total recovered lead | 25,498 | 18,533 | 41,149 | 55,323 | 54,254 |

## COMPARISON OF STATE TOTALS BASED ON SMELTER RETURNS AND ON MINE REPORTS.

The foregoing figures of the production of metallic lead by the respective States are compiled from reports of individual lead smelters and refineries. For several years the production of the more valuable metals in the Western States has been obtained by the Survey from reports of individual mines. In 1906 the same method was followed in the Eastern States, and in 1907 the plan was extended to take in the whole country. In order to put the smelter production on the same basis as the mine figures, all the lead which was produced as pigments directly from ore is added to the production of metallic lead. The lead recovered from secondary sources is excluded from these totals, since it has already been reckoned once as pig lead. These facts must be borne in mind in comparing this table with the preceding tables. The State totals obtained by each method for the last four years are compared in the following table:

*Comparison of State totals compiled from smelter and mine returns, 1908–1911, in short tons.*

| State. | 1908 | | | | 1909 | | | |
|---|---|---|---|---|---|---|---|---|
| | Totals based on smelter reports. | Totals based on mine reports. | Differences. | | Totals based on smelter reports. | Totals based on mine reports. | Differences. | |
| | | | Smelter excess. | Mine excess. | | | Smelter excess. | Mine excess. |
| Alaska | 3 | ..... | 3 | ..... | 60 | 19 | 41 | ..... |
| Arizona | 1,464 | 1,504 | ..... | 40 | 1,465 | 1,549 | ..... | 84 |
| Arkansas | ..... | 15 | ..... | 15 | 14 | 24 | ..... | 10 |
| California | 515 | 619 | ..... | 104 | 937 | 751 | 186 | ..... |
| Colorado | 30,852 | 26,100 | 4,752 | ..... | 30,912 | 36,084 | ..... | 5,172 |
| Idaho | 98,464 | 103,414 | ..... | 4,950 | 97,183 | 107,993 | ..... | 10,810 |
| Illinois | 363 | 399 | ..... | 36 | 273 | 295 | ..... | 22 |
| Iowa | 110 | 51 | 59 | ..... | 15 | 36 | ..... | 21 |
| Kansas | 2,825 | 2,518 | 307 | ..... | 3,085 | 1,300 | 1,785 | ..... |
| Kentucky | ..... | ..... | ..... | ..... | ..... | 10 | ..... | 10 |
| Missouri | 127,620 | 144,459 | ..... | 16,839 | 147,372 | 159,435 | ..... | 12,063 |
| Montana | 2,320 | 2,298 | 22 | ..... | 1,376 | 1,492 | ..... | 116 |
| Nevada | 3,796 | 3,623 | 173 | ..... | 4,698 | 4,920 | ..... | 222 |
| New Hampshire | ..... | ..... | ..... | ..... | 5 | ..... | 5 | ..... |
| New Mexico | 586 | 437 | 149 | ..... | 1,275 | 2,515 | ..... | 1,240 |
| Oklahoma | 1,577 | 1,781 | ..... | 204 | 2,820 | 3,427 | ..... | 607 |
| Oregon | 7 | 1 | 6 | ..... | 6 | ..... | 6 | ..... |
| South Dakota | 13 | 12 | 1 | ..... | ..... | 59 | ..... | 59 |
| Texas | 42 | 33 | 9 | ..... | 42 | 46 | ..... | 4 |
| Utah | 42,455 | 44,389 | ..... | 1,934 | 64,534 | 74,243 | ..... | 9,709 |
| Virginia | 13 | 38 | ..... | 25 | ..... | ..... | ..... | ..... |
| Washington | 593 | 575 | 18 | ..... | 115 | 144 | ..... | 29 |
| Wisconsin | 4,107 | 4,138 | ..... | 31 | 3,349 | 3,694 | ..... | 345 |
| Undistributed | 36 | ..... | ..... | ..... | 303 | ..... | ..... | ..... |
| Zinc residues | 1,290 | ..... | ..... | ..... | 1,641 | ..... | ..... | ..... |
| Total | 319,051 | 336,404 | ..... | ..... | 361,480 | 398,036 | ..... | ..... |

*Comparison of State totals compiled from smelter and mine returns, 1908–1911, in short tons*—Continued

| State. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Totals based on smelter reports. | Totals based on mine reports. | Differences. | | Totals based on smelter reports. | Totals based on mine reports. | Differences. | |
| | | | Smelter excess. | Mine excess. | | | Smelter excess. | Mine excess. |
| Alaska | 60 | 28 | 32 | ..... | 50 | 24 | 26 | ..... |
| Arizona | 858 | 1,348 | ..... | 490 | 3,450 | 5,137 | ..... | 1,687 |
| Arkansas | ..... | 63 | ..... | 63 | 21 | 64 | ..... | 43 |
| California | 1,160 | 1,435 | ..... | 275 | 615 | 699 | ..... | 84 |
| Colorado | 37,007 | 38,036 | ..... | 1,029 | 31,941 | 34,840 | ..... | 2,899 |
| Idaho | 99,924 | 114,129 | ..... | 14,205 | 117,159 | 136,278 | ..... | 19,119 |
| Illinois | 262 | 373 | ..... | 111 | 308 | 964 | ..... | 656 |
| Iowa | ..... | 20 | ..... | 20 | ..... | 60 | ..... | 60 |
| Kansas | 1,581 | 2,412 | ..... | 831 | 2,775 | 2,859 | ..... | 84 |
| Kentucky | 50 | 41 | 9 | ..... | ..... | ..... | ..... | ..... |
| Missouri | 166,617 | 161,016 | 5,601 | ..... | 187,388 | 178,868 | 8,520 | ..... |
| Montana | 1,790 | 2,053 | ..... | 263 | 2,499 | 3,216 | ..... | 717 |
| Nevada | 2,195 | 2,436 | ..... | 241 | 1,083 | 1,632 | ..... | 549 |
| New Mexico | 1,731 | 2,160 | ..... | 429 | 1,381 | 1,483 | ..... | 102 |
| Oklahoma | 2,612 | 2,888 | ..... | 276 | 2,553 | 2,501 | 52 | ..... |
| Oregon | ..... | ..... | ..... | ..... | 11 | ..... | 11 | ..... |
| South Dakota | 7 | 7 | ..... | ..... | 33 | 32 | 1 | ..... |
| Texas | 33 | 33 | ..... | ..... | 57 | 61 | ..... | 4 |
| Utah | 57,081 | 61,662 | ..... | 4,581 | 55,391 | 68,248 | ..... | 12,857 |
| Virginia | 87 | 99 | ..... | 12 | 400 | 417 | ..... | 17 |
| Washington | 311 | 661 | ..... | 350 | 601 | 424 | 177 | ..... |
| Wisconsin | 4,127 | 4,413 | ..... | 286 | 4,226 | 3,353 | 873 | ..... |
| Undistributed | 288 | ..... | ..... | ..... | 55 | ..... | ..... | ..... |
| Zinc residues | 2,049 | ..... | ..... | ..... | 1,991 | ..... | ..... | ..... |
| Total | 379,830 | 395,313 | ..... | ..... | 413,988 | 441,160 | ..... | ..... |

The smelter totals represent actual recovery and are found by summing up the total production reported by all companies for each State, respectively, and recalculating all pigments back to equivalent metallic lead on the basis of average analysis of product. In compiling the mine totals each producing property is requested to report actual tonnage of lead ores and concentrates shipped, and from this tonnage the lead content is reckoned by assay value. The quantities thus obtained from all the producing properties in each State are combined to make the total for that State. It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from every producing mine and smelter. It is further essential to the correctness of the mine totals that the assay content be correctly estimated.

With equal conditions affecting the mines and the smelters, the stocks in the ore bins of the smelters should run about even from year to year, and the mine and smelter State totals, making allowance in the former for losses in smelting, should show reasonable agreement. As may be seen from the table, however, there are frequent discrepancies. The causes of these discrepancies fall into four categories. The first is lag, by which is meant the time that elapses between the shipment of ore by the mine and the reduction of the ore by the smelter. This is frequently considerable, for ore raised near the end of the year may remain in the stock bins of the smelter until the succeeding year and, unless balanced by an equivalent lag from the preceding year, will thus lead to an apparent "mine

excess." Near the close of the year there were reports in the mining journals of the accumulation of 30,000 tons of lead ore at the Tooele smelter then under construction, but which did not blow in until 1912. The lead content of this ore appears as "mine excess" in the 1911 reports for the Western States, furnishing the ore, notably Utah and Idaho. If through accident, business depression, or otherwise, the mines close down, the smelters largely consume their ore stocks, which results in an apparent "smelter excess." The second source of difference is found in error in the mine totals, either in ore tonnage or in the arbitrary calculation of metal content from assay. The dry assay in vogue in the Western States gives results uniformly too low. A decision of the United States circuit court (T. D. 21653) recognizes a differential of 1.5 per cent between the dry assay and chemical analysis, and in actual practice the discrepancy is probably even greater than that figure. A third source is found in failure of the smelter returns to segregate accurately the ore from the different States. Until 1906 the ore coming from the Joplin district was lumped by the smelters as from Missouri or Missouri-Kansas, though some of it was from Oklahoma. This tended to make a smelter excess for Missouri and a mine excess for Kansas and Oklahoma. The same custom was to a certain extent true of the upper Mississippi Valley district. Though apportioned to the proper States since 1906, the division is confessedly a rough estimate in the case of some of the smelters which do not keep the ore from these regions separate on their books. Lastly, there is not taken into account in these totals, except in certain of the Western States, the loss in smelting, ranging from 2 to 5 per cent in treating easily reducible ores and up to 10 or more per cent in the more refractory ores. Losses running over 20 per cent have been claimed in smelting ores running high in antimony and arsenic. Lag being left out of account, each State would normally show a mine excess equal to this smelting loss. Any discrepancy which appears in the table may reasonably be ascribed to one or more of these items. In the long run, barring error and allowing for smelting losses and exportation of ore, the "mine excess" will be balanced by equivalent "smelter excess."

### SMELTER AND MINE STATE TOTALS IN 1911.

As no allowance for smelting losses has been made in the mine totals, except as noted, only those mine excesses which are notably above the normal loss in smelting need be discussed here. The mine excess in Arizona seems to be due to lag in smelting, a very natural condition seeing that the lead production of Arizona quadrupled in 1911. The mine excess in Colorado is probably due in part to smelting loss and in part to lag. The mine excess in Idaho is doubtless partly due to lag, owing to the increased output of that State in 1911, and partly due to the accumulation of lead ore stocks at the Tooele smelter while under construction. The mine excess in Illinois is due mostly to erroneous distribution, the lead being attributed to Wisconsin, as was also the case with the output of Iowa. The smelter excess in Missouri in 1911 and the smaller one in 1910, following large mine excesses in 1908 and 1909, are in all probability due to depletion of

Missouri lead ore stocks at the smelters. The mine excesses in Montana, Nevada, New Mexico, and particularly in Utah are in large part due to lag and to accumulation of ore stocks at the new Tooele smelter, as heretofore explained. The smelter excess in Washington is due to lag, and that of Wisconsin is due to error in distribution, the lead made from Illinois ore being in part credited to Wisconsin.

## RESOURCES.

### MINE PRODUCTION OF LEAD IN UNITED STATES IN 1911.

The following table shows for each lead-producing State the total quantity of lead-bearing ores produced and the output of each kind of lead-bearing ore. The column headed "All other ores" includes copper ore, copper-lead ore, and dry or siliceous ore. "Dry" ores produced in Colorado contained 9,559 short tons of lead. The total crude ore yielding either gold, silver, copper, lead, or zinc is given for each lead-producing State, so that a comparison may be made of the relative extent of deep mining operations in these States, the quantity of crude ore raised being the best measure for this purpose. As shown by the table, Missouri takes the same dominating position in the production of crude lead ore and lead-bearing zinc ores that was noted in the discussion of the table showing source of zinc mined in the United States in 1911 as given in the chapter on zinc in this volume. Missouri produced nearly two-thirds of the crude lead ore and nearly three-fourths of the crude lead-bearing zinc ore mined in the United States in 1911, and occupied the first rank in output of crude ore carrying any or all of the five metals named above.

The table gives also the quantity of lead contained in the crude ores of each State and the lead content of each kind of lead-bearing ore. The percentage of lead contained in the lead ore, the lead-zinc ore, and zinc ore of each State is also given. The lead content of lead ores ranges from 43.2 per cent in Texas down to 3.7 per cent in Missouri, the average for all the States being 5.5 per cent. The lead-zinc ores were somewhat less rich in lead than the lead ores, averaging 5.1 per cent. The average lead content of zinc ores was 0.4 per cent, this low figure being due to the preponderance of low-grade lead-bearing zinc ores in the Central States. Of the total mine production of lead in 1911, a quantity corresponding to 76.4 per cent was derived from lead ores, 10.7 per cent was derived from lead-zinc ores, 9.8 per cent was derived from zinc ores, and 3.1 per cent was recovered from all other ores. The figures of mine production of lead are taken from the chapters appearing elsewhere on mine production of gold, silver, copper, lead, and zinc in the various States.

*Source of lead mined in the United States in 1911, by States and kinds of ore, in short tons.*

| State. | Lead ores. | | | Lead-zinc ores. | | | Zinc ores. | | | All other ores. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Crude ore. | Lead content. | Percentage. | Crude ore. | Lead content. | Percentage. | Crude ore. | Lead content. | Percentage. | Crude ore. | Lead content. | Crude ore. | Lead content. |
| Alaska | | | | | | | | | | 1,663,379 | 51 | 1,663,379 | 51 |
| Arizona | 22,039 | 3,809 | 17.3 | 10,756 | 1,112 | 10.3 | 16,106 | 106 | 0.7 | 4,518,238 | 110 | 4,567,139 | 5,137 |
| Arkansas | | | | | | | 24,925 | 64 | .3 | | | 24,925 | 64 |
| California | 2,008 | 678 | 33.8 | | | | 4,625 | | | 2,937,555 | 21 | 2,944,188 | 699 |
| Colorado | 158,984 | 13,233 | 8.3 | 214,385 | 11,844 | 5.5 | 110,845 | 204 | .2 | 1,893,722 | 9,559 | 2,377,936 | 34,840 |
| Idaho | 1,559,724 | 120,206 | 7.7 | 397,354 | 15,549 | 3.9 | 51,050 | 514 | 1.1 | 162,769 | 9 | 2,170,897 | 136,278 |
| Illinois | | | | | | | 153,313 | 625 | .4 | (a) | 339 | 153,313 | 964 |
| Iowa | 1,000 | 60 | 6.0 | | | | | | | | | 1,000 | 60 |
| Kansas | | | | | | | 761,465 | 2,859 | .4 | | | 761,465 | 2,859 |
| Missouri | 3,974,712 | 146,821 | 3.7 | | | | 8,162,076 | 32,047 | .4 | | | 12,136,788 | 178,868 |
| Montana | 11,692 | 1,524 | 13.0 | 128 | 9 | 7.0 | 225,586 | 423 | .2 | 4,702,897 | 1,260 | 4,940,303 | 3,216 |
| Nevada | 5,018 | 859 | 17.1 | 4,654 | 576 | 12.4 | 3,013 | 91 | 3.0 | 4,120,036 | 106 | 4,132,721 | 1,632 |
| New Mexico | 3,175 | 606 | 19.0 | 16,333 | 779 | 4.8 | 8,402 | | | 204,789 | 98 | 232,699 | 1,483 |
| Oklahoma | | | | | | | 224,450 | 2,501 | 1.1 | | | 224,450 | 2,501 |
| South Dakota | 357 | 32 | 9.0 | | | | | | | 1,945,770 | | 1,946,127 | 32 |
| Texas | 88 | 38 | 43.2 | | | | | | | 21,644 | 23 | 21,732 | 61 |
| Utah | 393,079 | 48,747 | 12.4 | 280,817 | 17,550 | 6.2 | 5,753 | 5 | .1 | 6,588,881 | 1,946 | 7,268,530 | 68,248 |
| Virginia [b] | | | | | | | 16,704 | 417 | 2.5 | | | 16,704 | 417 |
| Washington | 1,653 | 418 | 25.3 | 51 | 6 | 11.8 | | | | 80,601 | | 82,305 | 424 |
| Wisconsin | | | | | | | 1,123,040 | 3,353 | .3 | | | 1,123,040 | 3,353 |
| Total | 6,133,529 | 337,031 | 5.5 | 924,478 | 47,425 | 5.1 | 10,891,353 | 43,209 | .4 | 28,840,281 | 13,522 | 46,789,641 | 441,187 |
| Percentage of total lead derived from each kind of ore | | 76.4 | | | 10.7 | | | 9.8 | | | 3.1 | | 100.0 |

[a] Lead concentrates are obtained as by-product in the milling of fluorspar ore in southern Illinois but the tonnage of crude fluorspar would not properly be classified among "All other ores" and is therefore omitted.

[b] Includes a small quantity of lead from New York.

## REVIEW BY DISTRICTS.

For details of production in the several lead-producing districts of the United States the reader is referred to the mine reports for the individual States appearing elsewhere in this volume. This review is based on those reports or on notes furnished by the authors of the various mine reports. Only the general trend of development during the year will be here considered in connection with the different districts.

### EASTERN STATES.

In the Eastern States numerous veins of lead have been prospected and worked spasmodically, though in but three or four States have these operations developed into the caliber of lead mines.

In New York lead ore has been mined in quantity in the northern part of the State, in the Rossie district, and in the southern part of the State, near Ellenville, Wurtzboro, and Guymard. In 1911 a vein of lead near Gouverneur was prospected and a small shipment of sorted ore was made to the smelter. This resulted in the recovery of a small quantity of lead and a nominal quantity of gold and silver.

The Virginia lead ores have been known and mined for more than 150 years, the mines at Austinville being the oldest workings. Lead ore, associated with zinc, occurs at the Pulaski, Austinville, Cedar Valley, and Albemarle mines. The production of lead by Virginia mines in 1911 (including the nominal output of New York) was 417 short tons—several times larger than the annual output for several years past.

In North Carolina lead ores have been mined in the Silver Hill district, Davidson County. The Washington mine, yielding argentiferous sulphides of zinc, lead, copper, and iron, was worked in 1836–1852 and some years thereafter to a depth of 650 feet. Other mines were worked later at Silver Valley and a smelter was erected at Thomasville, but there has been no production from the State for about 25 years.

The lead ores of Tennessee are subordinate to the zinc ores with which they generally occur. The New Prospect mine, in the Lead Mine Bend of Powell River, in Union County, has yielded both lead and zinc ores, but has not been worked for many years. The Blue Springs mine, 6 miles south of Cleveland, was operated for many years as a lead mine, though not lately. The zinc ores mined in Tennessee in 1911 yielded no lead, and there was no lead produced in the State during the year.

### CENTRAL STATES.

The Kentucky-Illinois fluorspar region yields some lead ore, mostly obtained as concentrates in the reduction of crude fluorspar. The production of lead from this source has been unimportant in the last few years, owing to the depression in the fluorspar industry. Some lead concentrates were recovered in 1911, but none were shipped. The recent enlargement of fluorspar concentrating plants in southern Illinois will no doubt lead to an increase in the output of lead concentrates from that region.

The upper Mississippi Valley region, embracing adjoining portions of Wisconsin, Illinois, and Iowa, was the scene of some of the earliest lead mining in the United States. The mines were at first

worked exclusively for lead, but since 1860 the production of zinc ore has predominated over that of lead ore, with which the zinc ore is associated in many mines. The lead content of lead concentrates produced in the district in 1911 was 4,038 short tons, as compared with 4,534 tons in 1910.

The southeast Missouri disseminated lead region has in recent years made the greatest gains in production of all the lead-producing districts of the United States, and since 1908 has annually exceeded the production of the Cœur d'Alene region, which formerly held first rank. The ore of the southeast Missouri region is almost wholly lead ore, although, particularly in the southern portion of the area, there is in many places considerable copper, nickel, and cobalt mixed with the lead. These occur in sufficient quantity to constitute the chief value of the ore in the North American mine at Fredericktown. An increasing quantity of zinc blende is also being found in the ore, ranging in the lead concentrates from a trace up to 5 per cent. Several of the milling plants remove the zinc as a table middling in concentration, and others similarly treat the copper-nickel-cobalt sulphides. The latter are salable, but no zinc recovered from the disseminated lead ore has been marketed. Silver also occurs in the ore to the extent of a little over 1 ounce to the ton of lead concentrates. The ore occurs in disseminated bodies of large size at depths ranging from 100 to 550 feet, though at a fairly definite geologic horizon. The crude ore in 1911 yielded 5 per cent of lead concentrates, which carried an average of 67.3 per cent of lead. The lead content of the lead ore mined in the southeast Missouri region in 1911, including also a small quantity from shallow lead mines in adjoining counties, was 147,754 short tons, as compared with 131,499 tons in 1910 and with 128,299 tons in 1909.

The production in 1911 was practically the output of six companies in St. Francois and Madison counties. Of three other companies in Madison County two—the North American and the Hudson Valley or Phoenix—were in financial difficulties and made no production; the third—the Madison Lead & Land Co.—leased the Catherine mine and mill to the Federal Lead Co. The Potosi Lead Co., which early in 1910 began a shaft near Leadwood, transferred its interests to the St. Louis Smelting & Refining Co.

The Joplin region includes southwest Missouri, southeast Kansas, and northeast Oklahoma. This is the greatest zinc-producing area in the United States and furnished nearly 40 per cent of the total recoverable zinc production of 1911. The lead is practically all recovered as a by-product in concentrating the zinc ores. The lead content of the lead concentrates produced in the Joplin region in 1911 was 36,474 short tons, as compared with 34,817 tons in 1910 and with 35,863 tons in 1909. The lead production of southwest Missouri was considerably curtailed by the closing down of many sheet-ground mines in the latter part of 1910 and the first part of 1911 on account of the low price of zinc, but during the latter part of the year the output of lead increased enough to make a gain of about 5 per cent for 1911 over 1910. Oklahoma had a somewhat smaller lead production, but Kansas gained enough to offset the loss.

North Arkansas made a small quantity of lead concentrates—about the same as in 1910—in milling zinc ores.

The Arbuckle Mountain region, in Oklahoma, has had no production of lead ore, although small quantities of lead occur in the rocks of the region in association with the zinc deposits.

WESTERN STATES.

The lead production of New Mexico continued to decline, being 1,483 tons in 1911, as compared with 2,160 tons in 1910 and with 2,515 tons in 1909. The principal production came from the Magdalena district, Socorro County, and about one-fourth of the whole was the output of Grant County. The lead mines of the Organ district in Dona Ana County continued idle.

Colorado showed a decrease in the mine production of lead, with an output of 34,840 tons in 1911, as compared with 38,036 tons in 1910. Lake County (Leadville district) led in the production of this metal by furnishing over one-fourth of the total. Pitkin County (Aspen district) ranked second, Mineral County (Creede district) was third, and San Juan (Animas and Eureka districts), San Miguel (Upper San Miguel district), and Summit counties followed in close order. About 15 counties produced more or less lead in 1911.

Montana in 1911 had an increased output of lead, aggregating 3,216 tons, as compared with 2,053 tons in 1910 and 1,492 tons in 1909. The lead came principally from the silver-lead mines of the Elkhorn district in Jefferson County, which had a larger quantity to their credit than in 1910. Silver Bow County also gained by the lead produced from occasional pockets found in proximity to the copper and zinc ore veins. Some lead concentrate is saved at the zinc mills.

Idaho had a very large increase in lead production, to 136,278 tons in 1911 from 114,129 tons in 1910, a gain of nearly 20 per cent. This is the greatest output the State has ever made. The largest gains were made in Shoshone, Lemhi, and Custer counties. The small lead furnaces at Enaville, in Shoshone County, and at Hahn, in Lemhi County, did not operate.

Utah increased its lead output from 63,799 tons in 1910 to 68,248 tons in 1911. The largest gains were made in Salt Lake, Summit, and Tooele counties. The mines in Juab and Utah counties decreased in output, owing to the working out of the principal ore channel in the eastern part of the Tintic district, where several mines made record outputs from 1907 to 1909.

Arizona increased in lead output to 5,137 tons in 1911 from 1,348 tons in 1910. Warren district in Cochise County is responsible for the larger part of the increase, but the renewal of shipments to the Needles smelter from several lead properties in Mohave County also contributed. Lessees operated in the Tombstone mines above the water level. The lower levels of this mine—up to the eighth—were flooded in 1909 and have not since been drained.

The lead output of Nevada decreased generally throughout the State, except in the Yellow Pine district, Clark County. A new production from Douglas County was added during the year. The railroad connecting with the lead districts in Eureka County was washed out in 1910 and had not been repaired in 1911. This, together with a largely reduced yield of lead in Mineral County, caused the State output to decrease to 1,632 tons as compared with 2,436 tons in 1910.

The lead production of California fell off more than 50 per cent, being 699 tons as against 1,435 tons in 1910. This output was obtained almost altogether from Inyo County, very small quantities coming from Mono and San Bernardino counties.

Washington mines, in Stevens and Pend Oreille counties, yielded 424 tons of lead in 1911, which was over one-third less than the State production of 1910, which was 661 tons. Nearly all of the output was derived from Cedar Canyon and Northport districts in Stevens County, and from a single lot of lead-zinc ore from the Metaline district in Pend Oreille County.

## METALLURGY.

### CONCENTRATION AND SEPARATION.

The problems of concentration and separation of lead ores do not differ essentially from those concerning zinc ores or the complex sulphide ores of lead and zinc. The various adaptations of the principles of flotation and of electrostatic separation to such ores have been discussed in the chapters on zinc in Mineral Resources of the United States for 1908 and for 1910, to which the reader is referred.

### SMELTING.

#### LEAD SMELTERS AND REFINERIES IN 1911.

In the following list the attempt has been made to give all the lead smelters and refineries in existence or under construction in the United States in 1911. The refinery of the International Lead Refining Co. is also included, although construction was begun after the close of 1911. The plants which produced in 1911 are given in ordinary type; those which were idle are listed in italics.

*List of lead smelters and refineries in the United States in 1910.*

ARIZONA:
- Mowry—*Consolidated Mines, Smelter & Transportation Co.*[1]

CALIFORNIA:
- Keeler—*Four Metals Mining & Smelting Co.*
- Needles—Needles Mining & Smelting Co.[2]
- Selby—Selby Smelting & Lead Co.[3] Refinery also.

COLORADO:
- Denver—Globe plant, American Smelting & Refining Co.
- Durango—Durango plant, American Smelting & Refining Co.
- Georgetown—Western Metals Co. (Malm dry chlorination process.) Under construction.
- Leadville—Arkansas Valley plant, American Smelting & Refining Co.
- Pueblo—Pueblo plant, American Smelting & Refining Co.
- Salida—Ohio & Colorado Smelting Co.

IDAHO:
- Enaville—*North Fork Smelting & Mining Co. Under construction.*
- Hahn—*Lemhi Smelting Co.*
- Ponderay—*Idaho Smelting & Refining Co.*
- Sea Foam—*Greyhound Mining & Milling Co.*

ILLINOIS:
- Aurora—Aurora Metal Co.[4]
- Chicago—National plant, American Smelting & Refining Co. Refinery only.
- Chicago—Goldsmith Bros.' Smelting & Refining Co.[4]
- Collinsville—St. Louis Smelting & Refining Co.[5] Refinery also.
- Federal—Federal Lead Co.[3]
- Granite City—Hoyt Metal Co.[5]

[1] Not operated for several years.
[2] Subsidiary of United States Smelting, Refining & Mining Co.
[3] Subsidiary of American Smelters Securities Co.
[4] Smelters of secondary materials, but treating some lead ores.
[5] Subsidiary of National Lead Co.

INDIANA:
East Chicago—International Lead Refining Co. Refinery only. Under construction.
Grasselli—United States Metals Refining Co.[1] Refinery only. Betts electrolytic process.
IOWA:
Dubuque—*J. W. Watters.*
KANSAS:
Galena—Galena Smelting & Manufacturing Co.
MISSOURI:
Desloge—Desloge Consolidated Lead Co.
Granby—Granby Mining & Smelting Co.
Herculaneum—St. Joseph Lead Co.
Joplin—Picher Lead Co.
Valle Mines—*Valle Mining Co.*[2]
Webb City—Webb City Smelting & Manufacturing Co.
MONTANA:
Cooke—*New World Smelter & Mining Co.*
East Helena—East Helena plant, American Smelting & Refining Co.
NEBRASKA:
Omaha—Omaha & Grant Smelting Co.[3] Refinery only. Betts electrolytic process.
NEVADA:
Nelson—*Santa Barbara Searchlight Mining Co.*
Spruce—*Black Forest Mines & Smelter Co.*
NEW JERSEY:
Newark—Balbach Smelting & Refining Co. Refinery also.
Perth Amboy—Perth Amboy plant, American Smelting & Refining Co. Refinery also.
NEW MEXICO:
Deming—*National Mining & Smelting Co.*[2]
PENNSYLVANIA:
Carnegie—Pennsylvania Smelting Co.
TEXAS:
El Paso—Kansas City Consolidated Smelting & Refining Co.[3]
UTAH:
Midvale—United States Smelting Co.[1]
Murray—Murray plant, American Smelting & Refining Co.
Silver City—*Tintic Smelting Co.*
Tooele—International Smelting & Refining Co.
WASHINGTON:
Keller—*Keller & Indiana Consolidated Smelting Co.*[2]
Tacoma—Tacoma Smelting Co.[4]
WISCONSIN:
Dodgeville—*Blue Mounds Mining & Smelting Co.*[2]
Waukesha—*Northern Smelting Co.*[2]

### NEW SMELTERS AND ADDITIONS TO CAPACITY.

The Webb City Smelting & Manufacturing Co. completed a new soft-lead smelter at Webb City, Mo., which blew in at the beginning of 1911. It was equipped with 6 Jumbo Scotch hearths, 2 small circular blast furnaces to reduce the gray slag, 2 drossing kettles, and ample bag-house capacity. The new smelter will use lead ore from the Joplin region, making the fourth smelter in the distict to use such ore, the others being the Granby, the Galena, and the Picher smelters.

The International Smelting & Refining Co. early in 1911 authorized the construction of 2 lead furnaces in connection with the

[1] Subsidiary of United States Smelting, Refining & Mining Co.
[2] Not operated for several years.
[3] Subsidiary of American Smelting & Refining Co.
[4] Subsidiary of American Smelters Securities Co.

copper smelter at Tooele, Utah. The furnaces have each a capacity of 250 tons of ore, and the first one blew in early in 1912. A late report is that 2 additional furnaces have been authorized, making a capacity of 1,000 tons in all. The plants are equipped with McDougall roasters and 4 large size Dwight & Lloyd sintering machines and a bag house containing 1,008 bags. A subsidiary of the same company, known as the International Lead Refining Co., has begun the construction of a lead refinery of 100 tons capacity at East Chicago, Ind. The Parkes process of desilverization will be used.

At the Omaha plant of the American Smelting & Refining Co. the Betts electrolytic process is replacing the Parkes process, the preliminary installation consisting of 80 tanks in 4 rows of 20 each, with 27 anodes and 28 cathodes to the tank.

In the matter of additions to equipment, Dwight & Lloyd sintering machines were installed in a number of plants. These additions were in some cases enumerated in the lead report for 1910, to which the reader is referred for further details and for a general outline of added metallurgical equipment in the last few years.

The smelter-fume problem continued to invite attack. A description of various plans proposed to overcome the objectionable fumes was given in the lead report for 1910. Where there is a market for sulphuric acid the sulphur gases may be converted into acid. But with a single western smelter discharging daily more than 500 tons of sulphur as $SO_2$,[1] it is clear that all the sulphur gases can not be profitably converted into sulphuric acid. The plans of simple neutralization of fume, although successful and at the present stage necessary, are nevertheless kept up at a dead expense and fall short of the goal of recovering a commercial by-product. Perhaps the most important of the later methods to solve the problem is the Thiogen process of Prof. S. W. Young, which proposes to recover sulphur as a by-product. An experimental plan for trying out the process has been installed at the copper smelter of the Penn Mining Co., at Campo Seco, Cal., to handle the gases from the McDougall roasters. The object of the process is to reduce the sulphur gases to sulphur by means of a spray of crude oil. The hot sulphur gases are drawn into a flue heated to low red heat, where they are sprayed with crude oil, pass thence through a number of porous partitions in which the gases are brought into contact with the hydrocarbon, and are thus reduced. From the flue the gases and sulphur pass into a condensing chamber where they are sprayed with water and the sulphur is condensed. The remaining gases are drawn through a short flue to a stack.

## TRADE CONDITIONS.

### WORLD'S PRODUCTION.

The following table of the production of lead in the world has been calculated from the statistics published by the Metallgesellschaft, of Frankfurt-am-Main, Germany, with the exception of the substitution of the figures collected by the United States Geological Survey for the production of the United States. It is to be noted that the production of Africa and South America is not separately given in the table. As shown on a preceding page, considerable lead has been

[1] Carpenter, F. R., Smelter fumes, their condensation and utilization: Proc. Colorado Sci. Soc., vol. 9, 1908, p. 65.

smelted and refined in the United States in the last four years from ores produced in those countries.

*The world's production of lead, 1904–1911, in short tons.*

| Country. | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|---|---|---|
| Australia | 131,615 | 117,946 | 102,514 | 106,923 | 131,174 | 85,098 | 108,907 | 109,789 |
| Austria-Hungary | 14,440 | 14,881 | 18,078 | 16,975 | 16,094 | 15,432 | 19,290 | 21,605 |
| Belgium | 25,904 | 25,243 | 24,471 | 28,417 | 39,352 | 44,423 | 44,864 | 33,951 |
| Canada | 18,960 | 28,329 | 26,235 | 13,338 | 18,849 | 22,928 | 16,535 | 11,795 |
| France | 20,723 | 26,565 | 28,219 | 25,353 | 28,770 | 29,652 | 22,266 | 25,353 |
| Germany | 151,676 | 168,211 | 166,117 | 157,156 | 180,887 | 185,076 | 176,258 | 177,801 |
| Great Britain | 26,896 | 25,684 | 26,455 | 30,203 | 32,738 | 31,085 | 32,628 | 29,872 |
| Greece | 16,755 | 15,102 | 13,338 | 15,212 | 17,637 | 16,865 | 18,519 | 15,763 |
| Italy | 25,904 | 21,054 | 23,479 | 25,243 | 28,660 | 24,361 | 15,983 | 18,408 |
| Japan | 1,984 | 2,535 | 3,858 | 3,858 | 3,197 | 3,748 | 3,858 | 3,858 |
| Mexico | 92,483 | 82,673 | 59,524 | 79,366 | 121,253 | 130,071 | 133,048 | 132,276 |
| Russia | 331 | 331 | 331 | 110 | 110 | 882 | 1,323 | 1,102 |
| Spain | 195,989 | 199,186 | 199,406 | 204,848 | 202,052 | 202,823 | 211,531 | 189,155 |
| Sweden | 661 | 661 | 882 | 882 | 331 | 220 | 441 | 2,866 |
| Turkey in Asia | 11,795 | 11,464 | 10,582 | 11,464 | 13,007 | 13,338 | 13,999 | 13,668 |
| Other countries | 331 | 220 | 220 | 220 | 551 | 6,393 | 17,306 | 20,944 |
| United States (domestic) | 307,000 | 302,000 | 350,153 | 365,166 | 310,762 | 354,188 | 372,227 | 392,842 |
| Total | 1,043,447 | 1,042,085 | 1,053,862 | 1,084,734 | 1,145,424 | 1,166,583 | 1,208,983 | 1,201,048 |
| United States percentage of world's production | 29.5 | 29.0 | 33.2 | 33.7 | 27.1 | 30.4 | 30.8 | 32.7 |

The world's production of lead declined a little from the point reached in 1910. The largest individual decrease was in the production of Spain, which fell off about one-sixth. Canada lost more than one-fourth from the previous year; Belgium about the same; and Great Britain and Greece also had decreased production. The United States had by far the largest output, more than double that of her nearest competitor, Spain, and constituting 32.7 per cent of the world's production.

## IMPORTS AND EXPORTS.

### WAREHOUSE TRANSACTIONS.

Lead imported into the United States as metal or in ore may be entered for immediate consumption, in which case the duty is paid and the lead goes direct to the consumer; or it may be entered for warehouse, bond being given for double the amount of the estimated duty. From warehouse the lead may be withdrawn for consumption by payment of duty, or it may remain in bond for smelting and refining, finally being either withdrawn for consumption or exported from warehouse with cancellation of bond. The lead entered for immediate consumption and that withdrawn from warehouse for consumption make up the table below of imports for consumption which are expressed in the same terms as those in which they were imported. The lead imported for consumption may be actually used in this country, or it may be manufactured into articles which are exported, in which case the manufacturer is entitled to the benefit of a drawback of 99 per cent of the duties paid. In the table below, showing foreign lead exported in manufactures with benefit of drawback, the lead is shown in the form in which it was originally imported. On account of diversity of form it is not feasible to show the

articles exported with benefit of drawback. The foreign lead given in the table below as exported from warehouse is likewise shown in the form in which it was imported and entered for warehouse.

The two items, foreign lead exported from warehouse and foreign lead exported in manufactures with benefit of drawback, make up the total foreign lead going out of the country. Lead in warehouse and deductions by liquidation being disregarded, the difference between the sum of these two exports of lead and the total imports of lead constitutes the foreign lead consumed in this country. For the sake of simplicity this foreign lead is carried on the bonded customs warehouse records in the form in which the lead was entered until the bond is canceled. It must be clearly understood, therefore, that in the table of foreign exports of lead, on a later page, the lead there listed was not exported as lead content of ore and base bullion but as refined lead smelted and refined from them. There is no record kept of the lead in the form in which it is actually exported except for a portion of the articles manufactured from foreign lead and exported with benefit of drawback. For articles not made wholly of lead it would be useless to give weights. But each shipment on which drawback is claimed is accompanied by a manifest of the imported lead used in making the articles and the duty paid thereon. From these manifests is derived the statement of the total quantity of foreign lead used in manufactures exported with the benefit of drawback. For this reason the lead is given in the form in which it was imported.

The following table, taken from the reports of the Bureau of Statistics, shows the lead remaining in warehouse at the close of each year, beginning with 1899, and also the district in which remaining. For the reasons given above, the lead is shown in the terms in which imported. For instance, a considerable part of the lead stated as remaining in ore and base bullion doubtless represents refined lead waiting at the bonded refinery for a favorable market for shipment. If this be borne in mind, the table gives a fair idea of the fluctuations of foreign stock at different times and in different localities.

*Lead remaining in warehouse, 1899–1911, in pounds.*

| Dec. 31— | Form in which entered for warehouse. | | Remaining at [a]— | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Lead in ore and base bullion. | Pigs, bars, and old. | Newark, N. J. | Perth Amboy, N. J. | Chicago, Ill. | El Paso, Tex. | San Francisco, Cal. | Puget Sound. |
| 1899 | 22,302,286 | 17,033 | 6,343,323 | 12,070,835 | 215,032 | 2,552,911 | 122,851 | 976,012 |
| 1900 | 42,379,270 | ..... | 10,692,307 | 10,157,018 | 2,236,555 | 2,642,568 | 3,149,975 | 6,147,500 |
| 1901 | 33,225,677 | 18,808 | 5,927,039 | 7,964,931 | ..... | 1,325,874 | 2,521,095 | 6,122,420 |
| 1902 | 47,817,806 | 59,487 | 8,198,289 | 14,176,702 | 4,157,558 | 2,949,481 | 3,745,809 | 2,073,152 |
| 1903 | 21,387,901 | ..... | 5,192,823 | 3,850,638 | 3,896,471 | 4,079,021 | 3,430,526 | 938,422 |
| 1904 | 22,962,984 | ..... | 1,629,852 | 7,482,560 | 5,999,972 | 6,062,072 | 1,732,742 | 46,295 |
| 1905 | 16,296,391 | 112 | 10,117 | 6,746,035 | 3,755,890 | 4,553,951 | 260,777 | 941,623 |
| 1906 | 11,382,998 | 128,812 | 1,743,853 | 3,870,951 | 2,736,979 | 229,267 | 306,607 | 2,480,817 |
| 1907 | 25,794,409 | 93,286 | 1,057,836 | 6,197,503 | 7,918,991 | 8,846,533 | 1,226,261 | ..... |
| 1908 | 36,923,604 | 206,651 | 6,772,049 | 23,356,695 | 3,950,517 | 2,381,867 | 15,526 | ..... |
| 1909 | 34,655,780 | 158,208 | 4,941,828 | 18,213,808 | 9,461,123 | 1,832,867 | 39,911 | ..... |
| 1910 | 71,794,443 | 149,082 | 7,548,936 | 36,112,136 | 21,090,631 | 6,937,667 | ..... | ..... |
| 1911 | 8,869,713 | 93,082 | 2,777,692 | 2,308,322 | 954,884 | 2,555,733 | ..... | ..... |

[a] Also in 1900 at Kansas City, Mo., 1,776,137 pounds, and at Omaha, Nebr., 5,306,351 pounds; in 1901, at Denver, Colo., 9,364,318 pounds; and in 1902, at Denver, Colo., 12,516,815 pounds.

## IMPORTS.

The following tables of lead and type metal imported and entered for consumption and of general imports of lead are taken from the reports and records of the Bureau of Statistics:

*Lead imported and entered for consumption in the United States, 1900–1911, in pounds.*

| Year. | Lead in ore.[a] | | Base bullion.[b] | | Pigs, bars, and old. | | Sheets, pipe, and shot. | | Not otherwise specified. | Total value. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | | |
| 1900 | 10,209,742 | $623,802 | ..... | ..... | 3,673,616 | $76,141 | 27,945 | $1,393 | $877 | $702,213 |
| 1901 | 10,324,119 | 272,396 | ..... | ..... | 3,604,157 | 88,056 | 56,735 | 2,773 | 1,234 | 364,459 |
| 1902 | 14,499,339 | 316,005 | ..... | ..... | 12,443,615 | 319,035 | 224,209 | 7,765 | 5,258 | 648,063 |
| 1903 | 41,155,130 | 716,128 | ..... | ..... | 8,972,635 | 255,135 | 17,008 | 810 | 1,589 | 973,662 |
| 1904 | 19,015,540 | 328,279 | ..... | ..... | 17,334,033 | 480,823 | 69,581 | 2,441 | 5,277 | 816,820 |
| 1905 | 49,526,990 | 784,548 | ..... | ..... | 10,379,753 | 329,209 | 77,668 | 3,813 | 1,139 | 1,118,709 |
| 1906 | 44,560,258 | 755,545 | 587,731 | $15,635 | 24,882,983 | 960,998 | 346,177 | 17,250 | 4,503 | 1,753,931 |
| 1907 | 13,363,875 | 286,802 | 1,196,224 | 35,303 | 15,667,170 | 718,198 | 734,418 | 39,210 | 3,450 | 1,082,944 |
| 1908 | 2,806,524 | 76,746 | 11,415,463 | 251,266 | 5,346,290 | 176,363 | 42,377 | 2,026 | 9,843 | 516,244 |
| 1909 | 7,080,753 | 142,847 | 21,896,611 | 454,568 | 7,095,442 | 229,751 | 40,434 | 2,056 | 32,284 | 861,506 |
| 1910 | 7,998,859 | 198,196 | 16,543,167 | 337,223 | 6,776,066 | 212,858 | 39,779 | 1,972 | 4,843 | 755,092 |
| 1911 | 1,474,254 | 26,563 | 17,376,459 | 352,595 | 7,112,749 | 242,423 | 63,151 | 2,855 | 7,218 | 631,654 |

[a] For period 1900–1905, inclusive, the gross weight and value of base bullion imported for consumption are also included.

[b] For the years previous to 1906 the imports of base bullion (gross weight) are not distinguished from imports of lead in ore.

*Type metal imported and entered for consumption, 1899–1911, in pounds.*

| Year. | Type metal. | | Lead content.[a] | |
|---|---|---|---|---|
| | Gross weight. | Value. | Pounds. | Percentage. |
| 1899 | 1,110,188 | $56,442 | ..... | ..... |
| 1900 | 1,032,866 | 51,242 | ..... | ..... |
| 1901 | 3,222,431 | 116,875 | ..... | ..... |
| 1902 | 6,469,971 | 194,394 | ..... | ..... |
| 1903 | 6,603,863 | 208,728 | ..... | ..... |
| 1904 | 8,143,749 | 221,127 | 6,884,423 | 84.5 |
| 1905 | 13,932,013 | 456,155 | 11,476,629 | 82.4 |
| 1906 | 19,602,471 | 900,608 | 15,896,629 | 81.1 |
| 1907 | 14,832,673 | 932,027 | 12,095,027 | 81.5 |
| 1908 | 4,110,486 | 156,847 | 3,265,815 | 79.5 |
| 1909 | 13,993,889 | 532,108 | 11,339,378 | 81.0 |
| 1910 | 13,394,199 | 485,493 | 11,176,830 | 84.9 |
| 1911 | 8,390,470 | 310,658 | 6,936,711 | 82.7 |
| Average lead content, 1904–1911 | ..... | ..... | ..... | 82.0 |

[a] Prior to 1904 the lead content of the type metal was not given. Besides lead, the chief constituent of the type metal is antimony.

*Imports of lead, in ore, base bullion, and refined, by countries, 1905–1911, in pounds.*

| Country. | 1905 | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|---|---|
| United Kingdom | 1,589,859 | 9,852,760 | 433,971 | 399,569 | 191,243 | 1,874,750 | 401,686 |
| Germany | 250,241 | 2,006,369 | 456,649 | 695,151 | 2,821,967 | 421,377 | 56,286 |
| Other European countries | 117,699 | 3,920,313 | 6,922,276 | 1,699,509 | 1,385,616 | 418,669 | 111,189 |
| Total from Europe | 1,957,799 | 15,779,442 | 7,812,896 | 2,794,229 | 4,398,826 | 2,714,796 | 569,161 |
| British North America | 16,362,916 | 18,514,244 | 13,272,900 | 1,291,044 | 4,133,755 | 206,979 | 270,947 |
| Mexico | 175,167,694 | 133,512,526 | 137,543,692 | 219,567,193 | 215,203,714 | 203,290,307 | 172,633,479 |
| South America | 3,154,483 | 315,265 | 883,355 | 469,770 | 1,942,847 | 6,598,263 | 4,778,221 |
| Other countries | 112,516 | 147,462 | 117,138 | 26,418 | 2,683,950 | 4,394,421 | 1,651,544 |
| Total imports | 196,755,408 | 168,268,939 | 159,629,981 | 224,148,654 | 228,363,092 | 217,204,766 | 179,903,352 |

In the foregoing table the lead imports in 1911 from Europe consisted about one-half of lead in ore. Of the lead imported from Mexico, 28,897,831 pounds was in ore, 141,481,852 pounds was contained in the base bullion, constituting the whole imports of base bullion into the United States, and 4,783,276 pounds was in the form of refined lead. From Chile there was imported 4,766,420 pounds of lead in lead ore and from German East Africa 1,640,517 pounds in lead ore.

The following table shows the imports of lead in ore, base bullion, and pigs, bars, sheets, and old for the years 1907–1911:

*Imports of lead, by classes, 1907–1911, in pounds.*

| Year. | Lead in ore (lead content). | Base bullion. | | Pigs, bars, sheets, and old. | Total lead content.[a] |
|---|---|---|---|---|---|
| | | Gross weight. | Lead content.[a] | | |
| 1907 | 64,815,254 | 76,259,828 | 74,594,313 | 18,554,899 | 157,964,466 |
| 1908 | 64,708,204 | 153,921,829 | 150,560,176 | 5,518,621 | 220,787,001 |
| 1909 | 71,357,868 | 149,852,559 | 146,579,779 | 7,152,665 | 225,090,312 |
| 1910 | 94,751,054 | 118,061,415 | 115,483,542 | 6,970,170 | 217,204,766 |
| 1911 | 35,686,180 | 141,481,852 | 138,952,372 | 5,264,800 | 179,903,352 |

[a] Lead content of bullion for 1907–1909 estimated on the basis of average lead content of imports of base bullion in 1910.

## EXPORTS.

### DOMESTIC EXPORTS.

The average difference between the New York and the London lead prices for the last 10 years has been not far from 1½ cents per pound. This being the case, domestic lead exports should be expected only under temporary and very unusual circumstances. The practice of the Bureau of Statistics is to class all exports of lead articles manufactured in this country as domestic exports, whether the lead be of domestic or foreign origin. The table of exported lead and manufactures of lead of domestic production, made up from the records of the Bureau of Statistics, and heretofore published in this report, must be duplicated in part, if not completely, in the following table of exports of manufactures with benefit of drawback. For this reason it has been decided to abandon the table of domestic exports, as previously published.

### FOREIGN EXPORTS.

By foreign lead exports is meant the exports of lead of foreign origin which has been smelted, refined, or manufactured in this country and then shipped abroad. The following table, made up from the records of the Bureau of Statistics, shows the total lead exported for a period of years, but it must be borne in mind, as pointed out on a previous page, that the actual exports were not in the form shown in the table which is the import form, but instead consisted of refined lead and lead manufactures. The quantities of lead exported from warehouse are exact, but the quantities given of lead in manufactures are subject to the waste in manufacturing.

Under the present tariff regulation the lead that must be sent out before the bond can be canceled is that actually recovered in smelting and refining the ore and base bullion. Under the preceding tariff the bond was canceled when 90 per cent of the lead content of the ore or gross weight of the base bullion was shipped out. If then, in refining base bullion, more than 90 per cent of the total weight was recovered as lead, the bond would be canceled on the exportation of that 90 per cent and the excess above 90 per cent could remain in this country without payment of duty. No doubt in past years considerable foreign lead used in this country has escaped duty in this wise.

*Exports of foreign lead, 1900–1911, in pounds.*

| Year. | Exported from warehouse. | | | | | | | Exported in manufactures with benefit of drawback. | |
|---|---|---|---|---|---|---|---|---|---|
| | Lead content ore.[a] | | Lead content base bullion.[a] | | Pigs, bars, and old. | | All other manufactures. | Lead content ore. | Pigs, bars, bullion, and old. |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Value. | Quantity. | Quantity. |
| 1900.. | 197,795,960 | $3,840,798 | ..... | ..... | 30,163 | $564 | $2,519 | 1,705,970 | 6,861,030 |
| 1901.. | 194,724,197 | 4,183,101 | ..... | ..... | 50,000 | 2,500 | 4,924 | 9,452,628 | 5,935,331 |
| 1902.. | 157,891,135 | 3,551,380 | ..... | ..... | 43,130 | 1,000 | 764 | 2,173,559 | 9,501,049 |
| 1903.. | 163,774,605 | 2,908,531 | ..... | ..... | 55,566 | 1,627 | 7,799 | 2,339,106 | 9,331,256 |
| 1904.. | 167,686,199 | 2,844,403 | ..... | ..... | 87,471 | 3,937 | 32,467 | 2,946,810 | 10,445,974 |
| 1905.. | 117,263,861 | 2,378,327 | ..... | ..... | 1,647,523 | 54,993 | 7,846 | 3,584,610 | 12,700,971 |
| 1906.. | 94,449,751 | 2,303,382 | ..... | ..... | 48,680 | 1,138 | 2,825 | 3,447,478 | 8,536,424 |
| 1907.. | 102,847,310 | 2,416,082 | ..... | ..... | 47,078 | 2,169 | 3,033 | 1,826,756 | 14,709,149 |
| 1908.. | 153,657,371 | 3,068,427 | ..... | ..... | 56,000 | 1,500 | 32,026 | 9,392,428 | 9,114,209 |
| 1909.. | 118,325,560 | 2,002,644 | [b] 53,817,393 | $1,036,080 | 11,447 | 487 | 697 | 2,992,967 | 6,598,149 |
| 1910.. | 22,508,090 | 248,220 | 117,045,333 | 2,262,057 | 19,507 | 703 | 870 | 6,592,294 | 11,008,604 |
| 1911.. | 38,154,747 | 730,247 | 151,988,265 | 3,093,290 | 12,311,102 | 244,037 | 1,504 | 674,621 | 23,485,929 |

[a] Prior to June, 1909, exports of foreign lead from warehouse do not distinguish between lead content of ore and gross weight of base bullion.
[b] For six months, July–December, 1909.

## CUSTOMS DUTIES.

The Payne-Aldrich tariff of 1909, effective August 6, 1909, made a reduction of ⅛ cent per pound in the duty on lead pipe, sheets, shot, wire, etc., and an important change in the section regulating the smelting and refining of lead in bond. The sections of the new tariff which are concerned with lead and lead products are as follows:

181. Lead-bearing ore of all kinds, one and one-half cents per pound on the lead contained therein: *Provided*, That on all importations of lead-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of Government officers, who shall be stationed at such establishments, and who shall submit the samples thus obtained to a Government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample and report the result to the proper customs officers, and the import entries shall be liquidated thereon, except in case of ores that shall be removed to a bonded warehouse to be refined for exportation as provided by law. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

182. Lead dross, lead bullion or base bullion, lead in pigs and bars, lead in any form not specially provided for in this section, old refuse lead run into blocks and bars, and old scrap lead fit only to be remanufactured; all the foregoing, two and one-eighth cents per pound; lead in sheets, pipe, shot, glaziers' lead and lead wire, two and three-eighths cents per pound.

191. Type metal, one and one-half cents per pound on the lead contained therein.

49. Red lead, two and five-eighths cents per pound.

53. White lead, and white pigment containing lead, dry or in pulp, or ground or mixed with oil, two and one-half cents per pound.

58. Lead: Acetate of, white, three cents per pound; brown, gray, or yellow, two cents per pound; nitrate of, two and one-fourth cents per pound; litharge, two and one-half cents per pound.

SEC. 24. That the works of manufacturers engaged in smelting or refining, or both, of ores and crude metals, may upon the giving of satisfactory bonds be designated as bonded smelting warehouses. Ores or crude metals may be removed from the vessel or other vehicle in which imported, or from a bonded warehouse, into a bonded smelting warehouse without the payment of duties thereon and there smelted or refined, or both, together with other ores or crude metals of home or foreign production: *Provided*, That the several charges against such bonds may be canceled upon the exportation or delivery to a bonded manufacturing warehouse, established under section twenty-three of this act, of the actual amount of lead produced from the smelting or refining, or both, of such ores or crude metals: *And provided further*, That said lead may be withdrawn for domestic consumption or transferred to a bonded customs warehouse and withdrawn therefrom upon the payment of the duties chargeable against it in that condition: *Provided further*, That all labor performed and services rendered pursuant to this section shall be under the supervision of an officer of the customs, to be appointed by the Secretary of the Treasury, and at the expense of the manufacturer: *Provided further*, That all regulations for the carrying out of this section shall be prescribed by the Secretary of the Treasury.

Under the tariff of 1897 the customs bond was canceled upon the exportation of 90 per cent of the weight of base bullion or lead contents of ore imported. Under the present tariff the bond is canceled only upon the exportation of the actual quantity of lead produced from the base bullion and ore. This change made it compulsory upon the Treasury Department to ascertain the exact recovery and wastage of lead. Prof. H. O. Hofman, of the Massachusetts Institute of Technology, was employed to investigate the wastage in both smelting and refining at the various bonded smelters. His report, being confidential, has not been given out by the Treasury Department. The following, taken from the Engineering and Mining Journal of June 17, 1911, purports to give the general results of the investigation:

It appears that Prof. Hofman in his investigations at the various bonded smelting warehouses found that there was a wide divergence in the amount of waste at the various places owing to the different character of the ores. He, therefore, recommended the establishment of the actual wastage at each plant as determined from a scrutiny of the records for three years back. * * * Prof. Hofman's reports showed that the wastage in smelting varied from 5 or 6 per cent at some plants to over 20 at others. There was also a wide variation of the loss incurred in refining base bullion, the figure running as low as less than 1 per cent in some cases, while in others it was very greatly in excess of that. Probably the most refractory ores studied by Prof. Hofman were those which were smelted at Perth Amboy, N. J. These are the Canadian ores, and the difficulty with them is due to the presence of large quantities of arsenates. Some plants have stopped smelting these ores on account of the high percentage of waste connected with them.

The Consolidated Kansas City Smelting & Refining Co. having protested the assessment of duty at El Paso upon both lead and zinc contents of an ore carrying more than 10 per cent of zinc, which zinc

was alleged to be lost in smelting, the Board of United States General Appraisers on June 27, 1910, affirmed (T. D. 30727) the imposition of duty upon both lead and zinc contents under the provisions of paragraphs 181 and 193 of the tariff of 1909. The plaintiff having carried the case to the United States Court of Customs Appeals, that body overruled the importers' claim (T. D. 31509) and sustained the action of the collector.

The American Smelting & Refining Co. protested the assessment of a duty of 2⅛ cents per pound upon antimonial lead withdrawn from the bonded smelting warehouse at Perth Amboy. It was claimed that the by-product, antimonial lead, is of the composition of type metal, that it was withdrawn for use as type metal, and that it should be dutiable at the rate of type metal—that is, 1½ cents per pound upon the lead contents thereof, as provided in paragraph 191 of the tariff of 1909. It was also urged that the same results could be secured by withdrawing the antimonial lead from bond for export and thereafter reimporting it as type metal. The United States Board of Appraisers (T. D. 31201) affirmed the assessment of duty and overruled the protest. The importers having appealed the case to the United States Court of Customs Appeals, that body, October 12, 1911, reversed the decision of the Board of Appraisers. During the course of the appeal it developed that antimonial lead has an average composition of 81 per cent of lead, 17 per cent of antimony, and 2 per cent of other metals, such as arsenic, copper, etc., and that since 1907 it has been regularly imported and entered for consumption as type metal. In this connection it may be remarked that a comparison of the table of production of antimonial lead showing the antimony content of that metal and the table of imports of type metal showing the lead content of that metal are in substantial agreement with the foregoing fact.

In response to a request for instructions from the collector of customs at El Paso regarding the proper classification of matte entered as copper matte, but containing from 4 to 18 per cent of lead, the Treasury Department ruled (T. D. 32439) that matte containing more than 10 per cent of lead is not properly a copper matte, entering duty free, but is dutiable under paragraph 181 of the tariff act of 1909 at 1½ cents per pound on the lead contained.

## CONSUMPTION.

In statements of lead consumption in these reports prior to 1907 it was the custom to take into account the smelter stocks of lead at the beginning and at the close of the year. It is not be be denied that for the individual year this gives closer figures. It is just as true that account of trade stocks should also be taken to arrive at accurate results; but this is manifestly outside the scope of this bureau. It has been found impossible to obtain a statement of stocks from one large producer since 1906; hence consumption has been calculated without reference to domestic stocks. A very considerable part, however, amounting to between one-fourth and one-fifth of the lead smelted and refined in this county, is lead of foreign origin smelted in bond, and it is possible to obtain the stocks of this portion, since they are reported annually by the Bureau of Statistics as "merchandise remaining in warehouse at close of year." A certain ele-

ment of error is introduced by the fact that the imports, the exports, and the warehouse stocks, as given, include lead in both ore and base bullion. So far as imports are concerned, the relative quantities of lead in ore and of base bullion are shown in the table on a preceding page, entitled "Imports of lead, by classes," based upon the records of the Bureau of Statistics, and corroborated in the preceding table giving the "sources of primary lead smelted or refined in the United States," based upon smelter reports. For exports and warehouse stocks no such division can be made, because the classes used therein represent the condition of the metal when imported, and do not change with the reduction of the metal in bond. Nevertheless, it is deemed advisable to use warehouse stocks as giving a better estimate of consumption. It is necessary, therefore, to include all classes of lead imports as well as all classes of lead exports.

In the following table "lead" includes all kinds—lead in ore, base bullion, pigs, bars, and old. The figures of domestic production are based upon the returns by the smelters; all other figures are from the records of the Bureau of Statistics. Decrease by liquidation covers losses in smelting and refining in bond and other corrections. Because warehouse stocks are used in lieu of smelter stocks the result given below is lead "available for consumption." The "apparent consumption" of previous reports would be this quantity increased or diminished by the increase or decrease of domestic stocks during the year.

*Consumption of primary lead in the United States, 1907–1911, in short tons.*

| | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|
| Supply: | | | | | |
| Stock in bonded warehouses Jan. 1 | 5,756 | 12,944 | 18,565 | 17,405 | 35,972 |
| Imports— | | | | | |
| For consumption | 15,246 | 9,805 | 18,036 | 15,359 | 13,281 |
| For warehouse | 64,569 | 102,241 | 96,145 | 93,249 | 76,671 |
| Production from domestic ores | 365,166 | 310,762 | 354,188 | 372,227 | 406,148 |
| Total supply | 450,737 | 435,752 | 486,934 | 498,240 | 532,072 |
| Withdrawn: | | | | | |
| Exports of foreign lead— | | | | | |
| From warehouse | 51,447 | 76,857 | 86,077 | 69,786 | 101,227 |
| In manufactures, with benefit of drawback | 8,268 | 9,254 | 4,796 | 8,800 | 12,080 |
| Decrease by liquidation | 4,578 | 13,425 | 8,643 | 7,661 | 14,812 |
| Stock in bonded warehouses Dec. 31 | 12,944 | 18,565 | 17,405 | 35,972 | 4,481 |
| Total withdrawn | 77,237 | 118,101 | 116,921 | 122,219 | 132,600 |
| Available for consumption | 373,500 | 317,651 | 370,013 | 376,021 | 399,472 |

For facility of comparison of consumption in the United States with that of the world, the consumption of the former has been calculated with and without stocks for a period of years, as shown in the following table. Consumption of lead, as shown in the second column, means the production of refined lead minus excess of exports over imports or plus excess of imports over exports. Additions made to stock during the year will thus appear as consumed, but as such stocks are apt to go into the market within the next year and cut down the apparent consumption to that extent, they must compensate in the long run, leaving an accurate average measure of the consump-

tion. The statistics of consumption of foreign countries as given in the table are taken from the estimates of the Metallgesellschaft, etc., which are also compiled without regard to stocks. In the following table, the first column gives, for the sake of comparison, the consumption with stocks taken into consideration; the remainder of the table disregards stocks. In neither column showing the United States consumption is the production of secondary lead taken into account.

*World's consumption of pig lead, exclusive of secondary lead, 1898–1911, in short tons.*

| Year. | Stocks considered. | Stocks disregarded. | | | |
|---|---|---|---|---|---|
| | United States. | United States. | Foreign countries. | Total world's consumption. | United States, percentage. |
| 1898 | 227,452 | 225,177 | 651,018 | 876,195 | 25.7 |
| 1899 | 226,315 | 230,294 | 652,782 | 883,076 | 26.1 |
| 1900 | 269,302 | 279,172 | 667,002 | 946,174 | 29.5 |
| 1901 | 271,934 | 284,126 | 663,805 | 947,931 | 29.9 |
| 1902 | 332,484 | 300,643 | 685,079 | 985,722 | 30.5 |
| 1903 | 300,167 | 284,556 | 701,945 | 986,501 | 28.8 |
| 1904 | 319,543 | 320,330 | 719,471 | 1,039,801 | 30.8 |
| 1905 | 347,015 | 343,682 | 736,998 | 1,080,680 | 31.8 |
| 1906 | 376,337 | 376,981 | 705,142 | 1,082,123 | 34.8 |
| 1907 | [a] 373,500 | 386,711 | 708,229 | 1,094,940 | 35.3 |
| 1908 | [a] 317,651 | 336,292 | 829,353 | 1,165,645 | 28.9 |
| 1909 | [a] 370,013 | 368,853 | 815,038 | 1,183,891 | 31.2 |
| 1910 | [a] 376,021 | 394,588 | 808,317 | 1,202,905 | 32.8 |
| 1911 | [a] 399,472 | 367,981 | 854,172 | 1,222,153 | 30.1 |

[a] See preceding table, "Consumption of primary lead in the United States" in 1907–1911.

*Consumption of lead, stocks and secondary lead disregarded, in 1906–1911, by by countries, in short tons.*

| Country. | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|---|
| Australia | 4,960 | 5,952 | 8,501 | 5,401 | 7,937 | 10,031 |
| Austria-Hungary | 26,235 | 27,778 | 31,906 | 34,171 | 34,722 | 40,013 |
| Belgium | 26,786 | 34,723 | 28,880 | 48,060 | 35,274 | 44,202 |
| Canada | 17,416 | 15,653 | 15,102 | 23,589 | 20,944 | 23,479 |
| France | 94,688 | 89,397 | 114,749 | 112,765 | 98,986 | 109,128 |
| Germany | 214,838 | 206,130 | 233,275 | 235,010 | 231,924 | 253,198 |
| Great Britain | 213,956 | 214,287 | 252,595 | 223,436 | 229,719 | 219,799 |
| Holland | 5,512 | 5,732 | 5,961 | 6,504 | 7,165 | 7,496 |
| Italy | 33,400 | 33,290 | 40,296 | 34,612 | 31,085 | 40,013 |
| Japan | 15,983 | 15,983 | 10,582 | 12,676 | 18,188 | 20,282 |
| Russia | 27,558 | 27,668 | 49,349 | 42,328 | 53,792 | 47,509 |
| Switzerland | 5,842 | 5,842 | 6,514 | 5,842 | 6,504 | 5,512 |
| Other European countries | 3,307 | 3,417 | 4,416 | 4,409 | 3,858 | 3,307 |
| Other countries | 14,661 | 22,377 | 27,227 | 26,235 | 28,219 | 30,203 |
| United States | 376,981 | 386,711 | 336,292 | 368,853 | 394,588 | 367,981 |
| Total | 1,082,123 | 1,094,940 | 1,165,645 | 1,183,891 | 1,202,905 | 1,222,153 |

## USE OF LEAD IN THE UNITED STATES.

The United States Geological Survey does not collect statistics of the use of lead. The following table is from figures published in the Engineering and Mining Journal, which purport to cover about 90 per cent of the total consumption. The figures for 1910 and 1911 are not available, but a fair idea may be gained from the years for which there are figures.

*Use of lead in the United States, 1907–1909.*

| | 1907 | | 1908 | | 1909 | |
|---|---|---|---|---|---|---|
| | Quantity. | Percentage. | Quantity. | Percentage. | Quantity. | Percentage. |
| | *Short tons.* | | *Short tons.* | | *Short tons.* | |
| White lead and oxides | 115,000 | 34.8 | 117,500 | 40.5 | 134,138 | 38.0 |
| Pipe | 41,000 | 12.4 | 33,800 | 11.6 | 52,914 | 15.2 |
| Sheets | 21,500 | 6.5 | 16,400 | 5.7 | 23,421 | 6.7 |
| Shot | 28,000 | 8.5 | 31,600 | 10.9 | 36,433 | 10.4 |
| Other purposes | 125,238 | 37.8 | 90,700 | 31.3 | 104,094 | 29.7 |
| Total | 330,738 | 100.0 | 290,000 | 100.0 | 351,000 | 100.0 |

## PRICES AND VALUE.

### PRICES.

Lead began the year at New York with a price of 4.5 cents a pound and remained at or slightly below this figure through six months. By the close of July the price had advanced to 4.6 cents. This price was maintained for about a month, but it receded through September and October, touching 4.275 cents, the minimum for the year, early in November. In the later part of that month the price was advanced to 4.475 cents, at which it closed the year. The average New York price for the year was 4.5 cents a pound, as compared to 4.4 cents in 1910, to 4.3 cents in 1909, and to 4.2 cents in 1908. These are the figures used in calculating the value of the lead production of the United States for those years.

The London price hovered around £13 a long ton (2.8 cents a pound) for the first six months. A gradual rise carried the price in November to £15 18s 9d a long ton (3.4 cents a pound), the highest London figures since 1907. The result is seen in the depletion of foreign lead in bonded smelting warehouses in the United States from 35,972 short tons at the beginning of the year to 4,481 tons at the close. The average London price of lead for the year was £13 8s 10d per long ton (3 cents per pound).

In the following table are shown the highest and the lowest prices of lead at New York in each month during the last 11 years. All figures for prices are in cents per pound. Those for 1906 and later are based upon daily quotations published in the Engineering and Mining Journal and those for preceding years on quotations published in the Iron Age:

*Highest and lowest prices of lead at New York City, monthly, 1901–1911, in cents per pound.*

| Year. | January. | | February. | | March. | | April. | |
|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| 1901 | 4.37½ | 4.37½ | 4.37½ | 4.37½ | 4.37½ | 4.37½ | 4.37½ | 4.37½ |
| 1902 | 4.10 | 4.00 | 4.10 | 4.05 | 4.10 | 4.05 | 4.10 | 4.05 |
| 1903 | 4.10 | 4.05 | 4.10 | 4.05 | 4.65 | 4.10 | 4.65 | 4.35 |
| 1904 | 4.50 | 4.25 | 4.50 | 4.40 | 4.60 | 4.50 | 4.60 | 4.50 |
| 1905 | 4.60 | 4.45 | 4.50 | 4.45 | 4.50 | 4.45 | 4.55 | 4.50 |
| 1906 | 5.60 | 5.60 | 5.60 | 5.35 | 5.35 | 5.35 | 5.50 | 5.35 |
| 1907 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 |
| 1908 | 3.80 | 3.55 | 3.75 | 3.70 | 4.00 | 3.65 | 4.10 | 3.90 |
| 1909 | 4.22½ | 4.12½ | 4.15 | 3.92½ | 4.10 | 3.92½ | 4.25 | 4.10 |
| 1910 | 4.70 | 4.70 | 4.70 | 4.52½ | 4.60 | 4.35 | 4.40 | 4.35 |
| 1911 | 4.52½ | 4.50 | 4.50 | 4.50 | 4.50 | 4.45 | 4.50 | 4.47½ |

*Highest and lowest prices of lead at New York City, monthly, 1901–1911, in cents per pound*—Continued.

| Year. | May. | | June. | | July. | | August. | |
|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| 1901 | 4.37½ | 4.37½ | 4.37½ | 4.37½ | 4.37½ | 4.37½ | 4.37½ | 4.37½ |
| 1902 | 4.10 | 4.05 | 4.10 | 4.05 | 4.10 | 4.05 | 4.10 | 4.05 |
| 1903 | 4.35 | 4.30 | 4.35 | 4.10 | 4.10 | 4.05 | 4.10 | 4.05 |
| 1904 | 4.50 | 4.25 | 4.35 | 4.20 | 4.30 | 4.10 | 4.20 | 4.10 |
| 1905 | 4.55 | 4.50 | 4.55 | 4.50 | 4.60 | 4.50 | 4.85 | 4.60 |
| 1906 | 5.75 | 5.50 | 5.75 | 5.75 | 5.75 | 5.75 | 5.75 | 5.75 |
| 1907 | 6.00 | 6.00 | 6.00 | 5.75 | 5.75 | 5.25 | 5.25 | 5.25 |
| 1908 | 4.37½ | 4.05 | 4.52½ | 4.32½ | 4.52½ | 4.40 | 4.62½ | 4.47½ |
| 1909 | 4.35 | 4.20 | 4.35 | 4.35 | 4.35 | 4.30 | 4.42½ | 4.27½ |
| 1910 | 4.37½ | 4.25 | 4.40 | 4.30 | 4.45 | 4.35 | 4.40 | 4.40 |
| 1911 | 4.47½ | 4.45 | 4.50 | 4.45 | 4.60 | 4.50 | 4.60 | 4.55 |

| Year. | September. | | October. | | November. | | December. | |
|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| 1901 | 4.37½ | 4.37½ | 4.37½ | 4.37½ | 4.37½ | 4.37½ | 4.37½ | 4.00 |
| 1902 | 4.10 | 4.05 | 4.10 | 4.05 | 4.10 | 4.05 | 4.10 | 4.05 |
| 1903 | 4.40 | 4.10 | 4.40 | 4 35 | 4.40 | 4.10 | 4.25 | 4.10 |
| 1904 | 4.25 | 4.20 | 4.30 | 4.20 | 4.50 | 4.20 | 4.65 | 4.60 |
| 1905 | 4.90 | 4.85 | 5.30 | 4.85 | 5.40 | 5.15 | 5.90 | 5.25 |
| 1906 | 5.75 | 5.75 | 5.75 | 5.75 | 5.75 | 5.75 | 6.00 | 5.75 |
| 1907 | 5.25 | 4.75 | 4.75 | 4.75 | 4.75 | 4.00 | 4.10 | 3.35 |
| 1908 | 4.60 | 4.52½ | 4.47½ | 4.20 | 4.40 | 4.25 | 4.30 | 4.12½ |
| 1909 | 4.40 | 4.32½ | 4.37½ | 4.32½ | 4.40 | 4.32½ | 4.70 | 4.37½ |
| 1910 | 4.40 | 4.40 | 4.40 | 4.40 | 4.50 | 4.40 | 4.50 | 4.50 |
| 1911 | 4.55 | 4.50 | 4.50 | 4.25 | 4.50 | 4.25 | 4.47½ | 4.47½ |

## PRICE CURVES.

The fluctuations in the price of lead at New York and London are graphically shown in figures 6, 7, and 8, which give curves of the weekly average price of lead in those markets for the years 1906–1911, inclusive. The independence of the New York market, except beyond the limit set by the tariff differential, is manifest, as is also the striking artificiality of that market.

### 1910.

The New York lead price curve for 1910 is a succession of level lines broken by slight advances and declines. The lowest point was reached in May, in sympathy with a depression in the London market. The range in weekly averages for the year was a little over four-tenths of a cent.

The London weekly average prices had a range of about three-tenths of a cent, and the curve for the year shows few oscillations. The low point was reached the first week in May, coincident with the renewal of the Lead Convention. With the close of 1910 the average weekly price of lead at London had fluctuated between 3 cents and a little under 2.7 cents for two and a half years.

New York and London prices preserved a close parallelism during the year. The average difference between the two markets was a little over 1.6 cents.

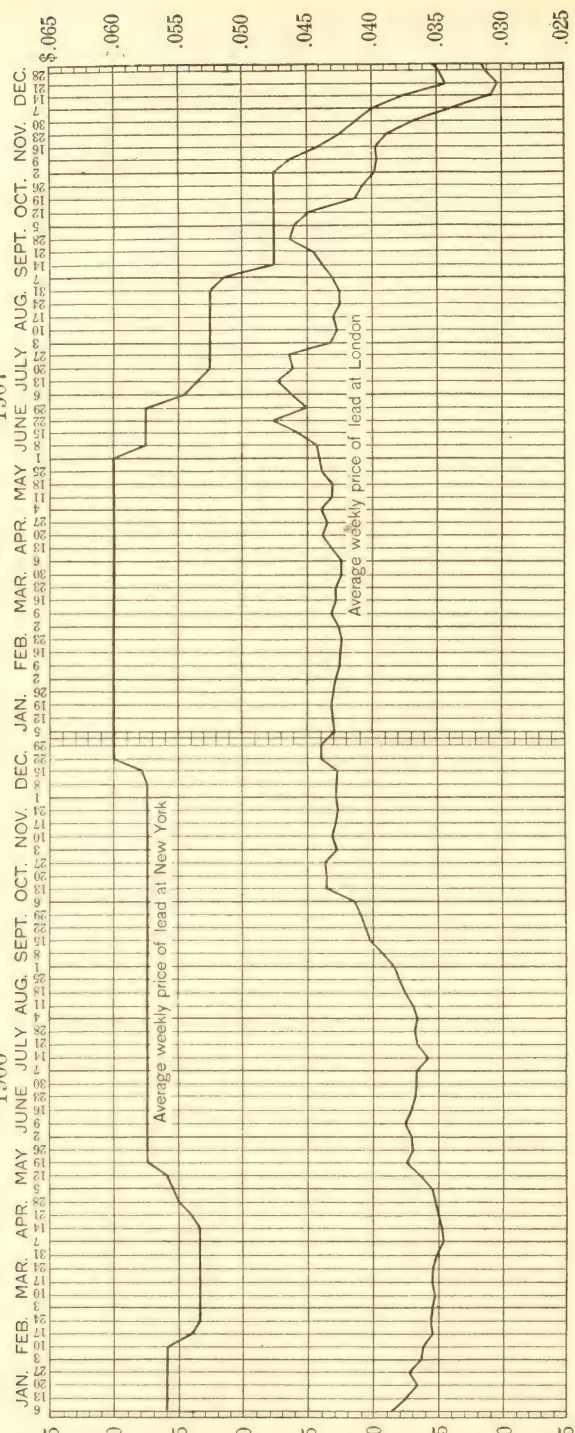



FIGURE 6.—Average weekly price of lead at New York and London in 1906 and 1907.

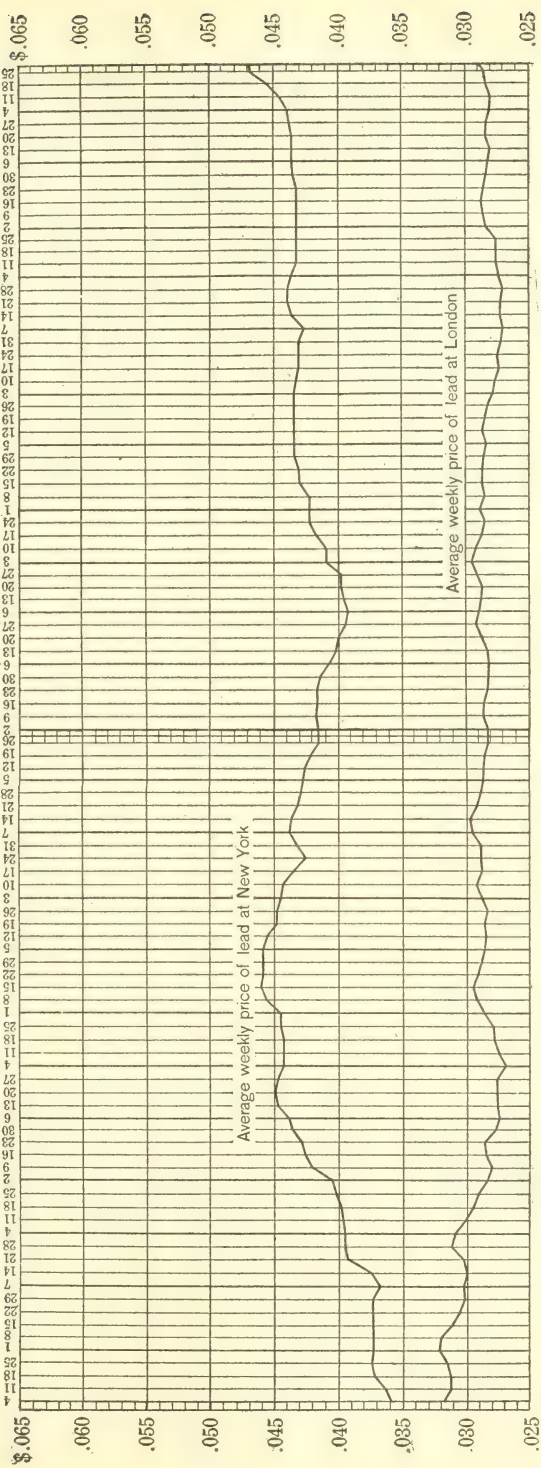



FIGURE 7.—Average weekly price of lead at New York and London in 1908 and 1909.

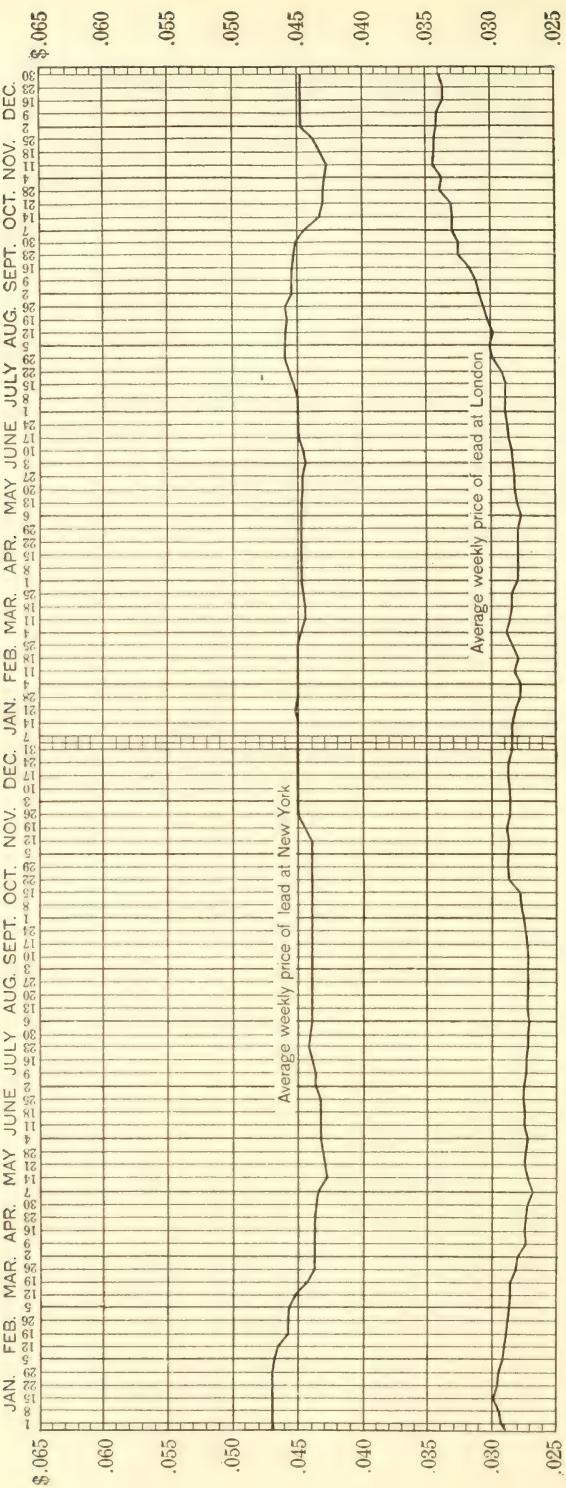



FIGURE 8.—Average weekly price of lead at New York and London in 1910 and 1911

1911.

The New York price of lead was almost stationary from the first of the year until the latter part of September, when there was a decline of about one-fourth of a cent a pound. The price rose by December 1, however, and the year closed with lead at practically the same figure as it began. In London the price oscillated slightly, but on the whole was nearly stationary through the first half of the year. During the latter half of the year a gradual rise brought lead to the highest figure received since 1907. Curiously enough the maximum weekly average price prevailed in London in the identical week that the minimum New York price occurred. The difference between the average New York and the average London price was 1½ cents a pound.

VALU

The value of the 406,148 short tons of lead produced in the United States in 1911 from domestic ores, based on the average New York price, was $36,553,320, as compared with 372,227 tons, valued at $32,755,976, in 1910, with 354,188 short tons, valued at $30,460,168, in 1909, and with 310,762 short tons, valued at $26,104.008 in 1908.

## CANADIAN LEAD BOUNTY.

The bounty paid by the Dominion of Canada to lead producers amounts to 75 cents per 100 pounds lead content of Canadian ore delivered to Canadian smelters when the London price of lead does not exceed £14 10s. per long ton (3.15 cents per pound). With increase in the price of lead the bounty decreases at the same ratio, ceasing altogether when lead is about £18 per long ton (3.91 cents per pound). The result of the bounty is to maintain to the producers a steady value for lead, under the present arrangement, of £18 per long ton.

Upon the termination of the first period of five years of operation of the bounty on June 30, 1908, it was renewed for a second period of five years, with the maximum and minimum London price limits each raised £2 per long ton, giving the figures cited above. The lead production of Canada is chiefly from the mines of British Columbia. Prior to the enactment of the bounty this lead was largely smelted and refined in the United States, but since that time the ore has been smelted in Canada.

The following figures, submitted to the meeting of the western branch of the Canadian Mining Institute, show the amounts paid during several periods to July 1, 1911, and the balance unexpended at that date of the $2,500,000 originally voted by the Dominion House of Commons for the payment of bounty on lead mined in Canada:

*Expenditure under Canadian lead-bounty act.*[1]

| | |
|---|---|
| Total expenditure (under first lead-bounty act) during period ended June 30, 1908 | $700,390.04 |
| Paid during fiscal year ended March 31, 1909 | 274,447.50 |
| Paid during fiscal year ended March 31, 1910 | 343,099.08 |
| Paid during fiscal year ended March 31, 1911 | 249,370.38 |
| Paid during fiscal year ended March 31, 1911[2] | 179,288.00 |
| Total amount paid as bounty on lead | 1,746,595.00 |
| Add amount appropriated for zinc-ore reduction experiments | 50,000.00 |
| Total | 1,796,595.00 |
| Balance still available as of April 1, 1912 | 703,405.00 |
| Total amount voted | 2,500,000.00 |

## THE LEAD CONVENTION.

The lead convention, formed at Paris early in 1909, and known as the International Sales Association, became effective May 1 of that year. It is composed of Spanish, Belgian, and German producers and metal-selling companies, together with Australian and American producers who consign lead to the European markets. The principal German producer, the Braubach silver-lead works, though not a member of the association, is acting in concert. The object of the association is to eliminate price cutting and sharp fluctuations and, by the establishment of a common selling agency and the allotment of spheres of sales, to introduce economies in the sale and delivery of lead. The Metallgesellschaft is the selling agency and Frankfort on the Main the chief market for metal controlled by the association, which is said to be about half the European supply.

At the close of the first year of the convention there were rumors of dissatisfaction among the members, and many predictions were made that the association would not be renewed. However, after a period of uncertainty which forced lead down to the lowest price of the year, the convention, in May, 1910, was established for another year, and it has been continued since. The association has had to meet the active competition of the independent producers and of the other large metal houses, in particular of Beer, Sondheimer & Co., who, through their Australian contracts and their control of the output of certain Spanish works and of the Rhine-Nassau and Overpelt works, were able to offer effective opposition.

That prices have been more stable and less subject to sudden fluctuations since the organization of the convention is evident from the price curves shown in figures 2, 3, and 4. Though the first two years of the convention were not marked by any advance in prices, the first half of the third year of its operation, as may be seen by an inspection of figure 4, has shown a gradual rise in the price of lead, carrying the metal to the highest point reached since the panic of

[1] Canadian Min. Jour., Oct. 15, 1911, p. 669.
[2] Canadian Engineer, Aug. 8, 1912.

1907, while at the same time the price in the United States has remained nearly stationary, or even lost a little.

It is reported that early in 1912 the International White Lead Convention was formed at London, by British, Continental, and American makers of white lead. Coincident with the formation of the association, there was an advance in the London price of white lead from £16 to £22 a ton, with white lead ground in oil advanced in proportion.

## SUMMARY.

The following tabular statement gives the general items regarding domestic and world production and consumption of lead. The figures for domestic items are those compiled by this office, and the figures for the world items are based upon statistics compiled by the Metallgesellschaft.

*Summary of lead statistics, 1907–1911, in short tons.*

| | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|
| Production of refined lead in the United States | 414,189 | 396,433 | 448,112 | 470,380 | 486,976 |
| Production of desilverized lead in the United States | 284,432 | 265,551 | 296,890 | 301,136 | 295,357 |
| Production of soft lead in the United States (including desilverized soft) | 129,757 | 130,882 | 151,222 | 169,244 | 191,619 |
| Production of antimonial lead in the United States | 9,910 | 13,629 | 12,896 | 14,069 | 14,078 |
| Total production of lead from domestic ores | 365,166 | 310,762 | 354,188 | 372,227 | 406,148 |
| Production of secondary lead in the United States | 25,498 | 18,533 | 41,149 | 55,323 | 54,254 |
| Consumption of lead in the United States (disregarding stocks) | 386,711 | 336,292 | 368,853 | 394,588 | 367,981 |
| World production (approximate) | 1,084,734 | 1,145,424 | 1,166,583 | 1,208,983 | 1,201,048 |
| World consumption (approximate) | 1,094,940 | 1,165,645 | 1,183,891 | 1,202,905 | 1,222,153 |
| United States (domestic) percentage of world production | 33.7 | 27.1 | 30.4 | 30.8 | 32.7 |
| United States percentage of world consumption | 35.3 | 28.9 | 31.2 | 32.8 | 30.1 |
| World rank of United States in production of lead | First. | First. | First. | First. | First. |
| World rank of United States in consumption of lead | First. | First. | First. | First. | First. |

## BIBLIOGRAPHY.

A list of the more important publications on lead and zinc published by the United States Geological Survey is given in the chapter on zinc in this volume.

# ZINC.

By C. E. Siebenthal.

## INTRODUCTION.

An estimate of the production of primary [1] spelter in 1911 was given out in the form of a press bulletin on January 2, 1912. This was based on reports from every smelter and gave the actual production for the first 11 months with an estimate for the remainder of the year. The total thus obtained was about one-half of 1 per cent in excess of the final figures which were given in the advance statement of spelter production and consumption published February 9, 1912.

In July, 1911, a midyear census was taken of the production of spelter during the first six months of the year, and the results were given out in the form of a press bulletin. This plan was so well received by producers and others that it will be a feature of the future zinc reports, as it was formerly, from 1892 to 1901, inclusive. The production for the semiannual periods of 1911 is given on a later page.

The present report includes the final figures as given out in the advance statement and contains in addition tables of imports and exports of spelter and of zinc ore, a comparison of mine and smelter returns, a list of zinc smelters, a brief review of the advance in metallurgy and ore dressing as applied to zinc ores, and finally a summary of the domestic and foreign conditions of the zinc industry.

The statistics of production in this country have been compiled by the United States Geological Survey from confidential reports by each zinc smelting company in operation during 1911, except one small plant, using both ore and skimmings, which refused to report. For this company a close estimate of the spelter made from ore, amounting to only a few hundred tons, has been obtained. Statistics of the recovery of secondary zinc were collected from all the important secondary smelters and refiners. The statistics of domestic consumption are taken in part from the smelter returns and in part from the records of the Bureau of Statistics of the Department of Commerce and Labor, and the tables for foreign production and consumption were compiled from the sources indicated.

[1] In Mineral Resources for 1906, p. 461, zinc derived from ore was called "primary" spelter to distinguish it from the secondary spelter recovered from such sources as drosses, skimmings, and old metal. The former has also been called "virgin" spelter, and the latter has been called "remelted," "reclaimed," and "dross" spelter. The distinctive origin is more plainly suggested by the terms "primary" spelter and "secondary" spelter, and they are used herein. Where the word "spelter" is used without qualification primary spelter will be understood.

## STATE OF ZINC INDUSTRY IN 1911.

The production of primary spelter from domestic ores in 1911 was 271,621 short tons, valued at $30,964,794, based on the average St. Louis price, as compared with 252,479 short tons, valued at $27,267,732, based on the average St. Louis price, in 1910.

The total production of spelter from both domestic and foreign ores in 1911 was the greatest in the history of the zinc-smelting industry of the United States, being 286,526 short tons, as against 269,184 tons in 1910, a gain of 17,342 tons, or 6.4 per cent. Along with this increase in production there was a large increase in the consumption, which was nearly 10,000 tons greater than the abnormal consumption of 1909. This resulted in diminishing the stocks at smelters over 14,000 tons. The imports of spelter reached the lowest figure in recent years, while exports, both foreign and domestic, increased about one-half over those of 1910. The total production of spelter in 1911 was equal to the output of 67,418 average retorts operating continuously throughout the year, or about 80 per cent of the effective smelting capacity at the beginning of the year, estimated as working upon 60 per cent zinc concentrates. During the year, however, several plants were dismantled, and in addition much low-grade ore was smelted, so that no doubt at the close of the year the high price of spelter stimulated production to the limit of capacity. The United States retained first place in the world's production of spelter with 29.3 per cent of the total output.

The exodus of zinc smelters from Kansas which began in 1910 kept up during 1911, and of the 16 plants with 47,214 retorts which were in existence at the close of 1910, but 10 plants with 31,378 retorts were left at the close of 1911. For several years, however, owing to the failure of supplies of natural gas, several of the plants had been idle or had operated at part capacity, so that the actual smelter output of Kansas for 1911 was nearly up to the average production of the last four years. The discovery of new gas fields in Oklahoma within piping distance of the newer, larger smelters in southern Kansas, the use of crude oil as fuel, and the remodeling of coal-burning smelters will doubtless result in sustaining the spelter output of Kansas for some time

## PRODUCTION.

### ANNUAL PRODUCTION, 1873–1911.

The production of spelter in the United States began in 1858 in an experimental way [1] and regular production began in 1860 at the Lehigh Zinc Works in the East and at the Matthiesson & Hegeler works in the West. Between 1864 and 1870 nine or ten other zinc smelters were established. Statistics of production are recorded for the years 1873 and 1875 and for the census year ending May 31, 1880. Annual statistics have been collected by the United States Geological Survey since 1882. The annual progress of the zinc-smelting industry since 1873 is shown in the following table.

[1] Ingalls, W. R., Lead and zinc in the United States, p. 314.

*Annual production of spelter in the United States from domestic and foreign ores, 1873–1911, in short tons.*

| Year. | From foreign ore. | From domestic ore. | Total. | Year. | From foreign ore. | From domestic ore. | Total. |
|---|---|---|---|---|---|---|---|
| 1873 | ..... | 7,343 | 7,343 | 1896 | ..... | 81,499 | 81,499 |
| 1875 | ..... | 15,833 | 15,833 | 1897 | ..... | 99,980 | 99,980 |
| 1880 | ..... | 23,239 | 23,239 | 1898 | ..... | 115,399 | 115,399 |
| 1882 | ..... | 33,765 | 33,765 | 1889 | ..... | 129,051 | 129,051 |
| 1883 | ..... | 36,872 | 36,872 | 1900 | ..... | 123,886 | 123,886 |
| 1884 | ..... | 38,544 | 38,544 | 1901 | ..... | 140,822 | 140,822 |
| 1885 | ..... | 40,688 | 40,688 | 1902 | ..... | 156,927 | 156,927 |
| 1886 | ..... | 42,641 | 42,641 | 1903 | ..... | 159,219 | 159,219 |
| 1887 | ..... | 50,340 | 50,340 | 1904 | ..... | [a] 186,702 | 186,702 |
| 1888 | ..... | 55,903 | 55,903 | 1905 | ..... | [a] 203,849 | 203,849 |
| 1889 | ..... | 58,860 | 58,860 | 1906 | 25,076 | 199,694 | 224,770 |
| 1890 | ..... | 63,683 | 63,683 | 1907 | 26,115 | 223,745 | 249,860 |
| 1891 | ..... | 80,873 | 80,873 | 1908 | 19,675 | 190,749 | 210,424 |
| 1892 | ..... | 87,260 | 87,260 | 1909 | 25,535 | 230,225 | 255,760 |
| 1893 | ..... | 78,832 | 78,832 | 1910 | 16,705 | 252,479 | 269,184 |
| 1894 | ..... | 75,328 | 75,328 | 1911 | 14,905 | 271,621 | 286,526 |
| 1895 | ..... | 89,686 | 89,686 | | | | |

[a] Including an unknown quantity smelted from foreign ore, small in 1904 but larger in 1905.

## PRODUCTION BY STATES.

*Production of primary spelter in the United States in 1906–1911, apportioned according to source of ore, in short tons.*

| Source. | Quantity. | | | | | | Percentage of total in 1911. |
|---|---|---|---|---|---|---|---|
| | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 | |
| Arizona | 64 | 77 | 152 | 2,862 | 2,594 | 2,476 | 0.91 |
| Arkansas | 1,801 | 1,911 | 2,002 | 135 | 286 | 385 | .14 |
| California | ..... | 140 | 27 | ..... | ..... | 959 | .35 |
| Colorado | 32,456 | 26,077 | 24,885 | 20,121 | 23,238 | 42,233 | 15.55 |
| Idaho | 573 | 3,508 | 581 | 901 | 3,454 | 3,180 | 1.17 |
| Illinois | 282 | 1,446 | 298 | 675 | 1,551 | 2,884 | 1.06 |
| Iowa | 201 | 220 | 516 | ..... | 40 | ..... | ..... |
| Kansas | 3,902 | 13,850 | 8,628 | 9,185 | 10,220 | 6,843 | 2.52 |
| Kentucky | 335 | 358 | 341 | 22 | 29 | 205 | .08 |
| Maine | ..... | 1 | ..... | ..... | ..... | ..... | ..... |
| Missouri | 130,348 | 141,824 | 123,655 | 140,676 | 140,652 | 127,540 | 46.96 |
| Montana | 1,415 | ..... | 900 | 4,725 | 12,408 | 22,115 | 8.14 |
| Nevada | 1,768 | 1,692 | 398 | 825 | 1,516 | 1,595 | .59 |
| New Jersey | 11,206 | 13,573 | 6,926 | 16,035 | 20,217 | 15,128 | 5.57 |
| New Mexico | 555 | 136 | 134 | 3,961 | 4,911 | 3,778 | 1.39 |
| Oklahoma | ..... | 719 | 2,235 | 3,008 | 2,297 | 2,247 | .83 |
| Tennessee | 124 | 181 | 341 | 695 | 925 | 1,000 | 0.37 |
| Texas | 8 | 16 | ..... | ..... | ..... | ..... | ..... |
| Utah | 2,449 | 1,972 | 282 | 5,960 | 7,221 | 7,004 | 2.58 |
| Virginia | 1,143 | 771 | 910 | 58 | 1,168 | 228 | .08 |
| Washington | 7 | ..... | ..... | ..... | ..... | 12 | ..... |
| Wisconsin | 11,057 | 15,273 | 17,538 | 20,381 | 19,752 | 31,809 | 11.71 |
| Total from domestic ores | 199,694 | 223,745 | 190,749 | 230,225 | 252,479 | 271,621 | 100.00 |
| Foreign: | | | | | | | |
| Canada | 201 | 545 | 2,425 | 978 | 3,304 | 1,598 | ..... |
| Mexico | 24,875 | 25,570 | 17,250 | 24,557 | 13,401 | 13,307 | ..... |
| Total from foreign ores | 25,076 | 26,115 | 19,675 | 25,535 | 16,705 | 14,905 | ..... |
| Grand total | 224,770 | 249,860 | 210,424 | 255,760 | 269,184 | 286,526 | ..... |

Two tabulations of the spelter production of the country for a period of years are given, one showing the locality from which the ores were derived, the other the locality in which they were smelted.

Each method has its special interests and advantages, depending on whether the viewpoint be that of producer or consumer, or that of resources.

The State totals as given are compiled entirely from confidential reports by each company engaged in smelting zinc ores in the United States in the year in question. Only primary spelter is here included, the recovery of secondary spelter being given in a later table.

The foregoing table shows the sources of all ores and concentrates smelted for spelter in the United States in 1906–1911 and the quantity of spelter actually derived from the ores from these respective sources. Statistics of production according to source of ore were not collected prior to 1906.

The subjoined table shows the localities in which spelter was made:

*Production of spelter in the United States, 1873–1911, apportioned according to locality in which smelted, in short tons.*

| Year. | Illinois. | Kansas. | Missouri. | Oklahoma. | Eastern. | Southern. | Colorado. | Total. |
|---|---|---|---|---|---|---|---|---|
| 1873 | | | | | | | | 7,343 |
| 1875 | 6,678 | 600 | 4,650 | | 3,305 | | | [a] 15,833 |
| 1880 (census) | 10,904 | 2,451 | 5,671 | | 4,213 | | | 23,239 |
| 1882 | 18,201 | 7,366 | 2,500 | | 5,698 | | | 33,765 |
| 1883 | 16,792 | 9,010 | 5,730 | | 5,340 | | | 36,872 |
| 1884 | 17,594 | 7,859 | 5,230 | | 7,861 | | | 38,544 |
| 1885 | 19,427 | 8,502 | 4,677 | | 8,082 | | | 40,688 |
| 1886 | 21,077 | 8,932 | 5,870 | | 6,762 | | | 42,641 |
| 1887 | 22,279 | 11,955 | 8,660 | | 7,446 | | | 50,340 |
| 1888 | 22,445 | 10,432 | 13,465 | | 9,561 | | | 55,903 |
| 1889 | 23,860 | 13,658 | 11,077 | | 10,265 | | | 58,860 |
| 1890 | 26,243 | 15,199 | 13,127 | | 9,114 | | | 63,683 |
| 1891 | 28,711 | 22,747 | 16,253 | | 8,945 | 4,217 | | 80,873 |
| 1892 | [b] 31,383 | 24,715 | 16,667 | | 9,582 | 4,913 | | 87,260 |
| 1893 | [b] 29,596 | 22,815 | 13,737 | | 8,802 | 3,882 | | 78,832 |
| 1894 | [b] 28,972 | 25,588 | 11,992 | | 7,400 | 1,376 | | 75,328 |
| 1895 | [b] 35,732 | 25,775 | 14,998 | | 9,484 | 3,697 | | 89,686 |
| 1896 | [b] 36,173 | 20,759 | 14,001 | | 8,139 | 2,427 | | 81,499 |
| 1897 | [b] 37,876 | 33,396 | 18,125 | | 7,218 | 3,365 | | 99,980 |
| 1898 | [b] 47,103 | 40,132 | 19,533 | | 8,631 | | | 115,399 |
| 1899 | [b] 50,118 | 52,021 | 18,107 | | 8,805 | | | 129,051 |
| 1900 | [b] 38,750 | 62,136 | 14,741 | | 8,259 | | | 123,886 |
| 1901 | [b] 44,896 | 74,240 | 13,083 | | 8,603 | | | [a] 140,822 |
| 1902 | [b] 47,096 | 86,564 | 11,087 | | 12,180 | | | [a] 156,927 |
| 1903 | [b] 47,659 | 88,388 | 9,994 | | 12,301 | | 877 | [a] 159,219 |
| 1904 | 47,740 | 107,048 | 12,150 | | 14,893 | | 4,871 | [a] 186,702 |
| 1905 | 46,606 | 114,287 | 11,844 | | 24,513 | | 6,599 | [a] 203,849 |
| 1906 | 47,939 | 129,564 | 11,077 | | 29,930 | | 6,260 | 224,770 |
| 1907 | 56,056 | 134,108 | 11,732 | 5,035 | 37,626 | | 5,303 | 249,860 |
| 1908 | 50,244 | 99,298 | 10,201 | 14,864 | 32,738 | | 3,079 | 210,424 |
| 1909 | 67,653 | 103,299 | 7,037 | 28,782 | 42,941 | | 6,048 | 255,760 |
| 1910 | 73,038 | 105,697 | 5,571 | 34,760 | 43,606 | | 6,512 | 269,184 |
| 1911 | 83,130 | 98,413 | 4,116 | 46,315 | 47,155 | | 7,397 | 286,526 |

[a] Secondary spelter included: 600 tons in 1875; 2,716 tons in 1901; 2,675 tons in 1902; 3,302 tons in 1903; 3,300 tons in 1904; and 1,469 tons in 1905.

[b] Includes also the production of smelters in Indiana.

Owing to the fact that this chapter can not be prepared for publication until the latter part of the year and after the figures of the mid-year spelter statement are available, those figures were utilized in the following table of production by States for six-month periods,

though they include one period in advance of the volume for the year:

*Production of spelter in the United States, 1911–12, by six-month periods, apportioned according to locality in which smelted, in short tons.*

| State. | Jan. 1 to June 30, 1911. | July 1 to Dec. 31, 1911. | Jan. 1 to June 30, 1912. |
|---|---|---|---|
| Illinois | 41,255 | 41,875 | 44,224 |
| Kansas | 50,574 | 47,839 | 52,485 |
| Oklahoma | 19,997 | 26,318 | 36,010 |
| All other States | 28,370 | 30,298 | 33,777 |
| Total | 140,196 | 146,330 | 166,496 |

The following curves show graphically the production and consumption of spelter in the United States in the period for which

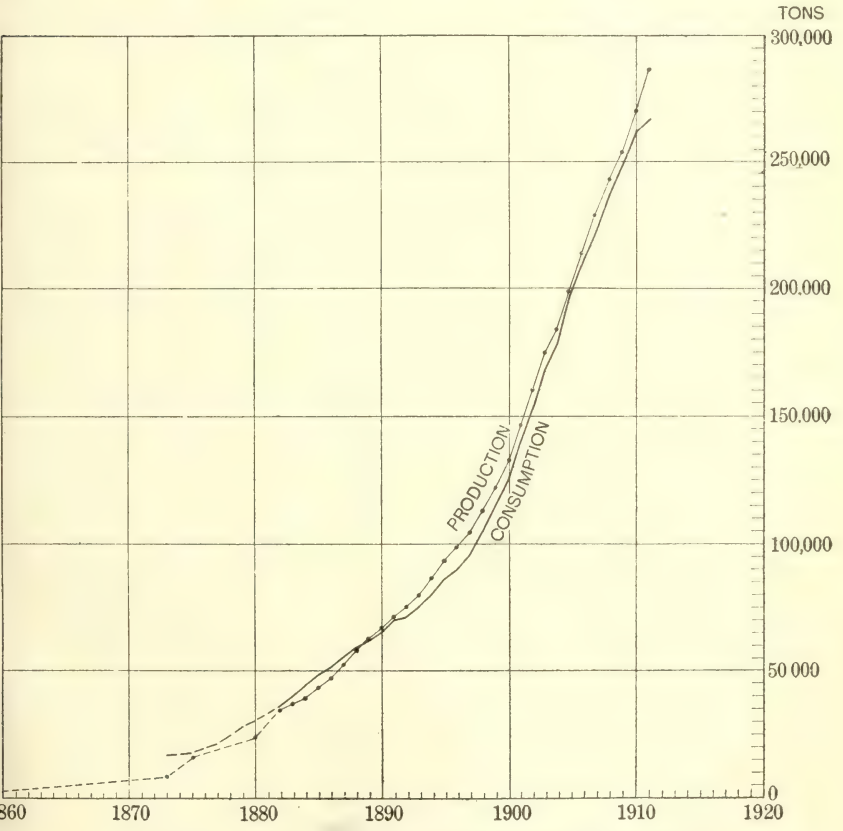



FIGURE 9.—Curves of spelter production and consumption, 1873–1911.

there is record. The curves are made up of 9-year averages, that is, the point in the curve representing each year is the average of the actual quantity for the year as well as of the four years preceding and

the four years following that year. This method practically eliminates the effects of temporary factors, affecting the production or consumption for one or two consecutive years. The resulting curves therefore approach the true curves of normal production and consumption. Naturally the smoothing effects of the method are less pronounced near the ends of the curves, which remain more or less irregular. No distinction is made between spelter of domestic and of foreign origin in this table. From the beginning of the period until 1888 the average consumption exceeded production. Since that year the average production has always exceeded the average consumption. The consumption figures, as taken, disregard all stocks.

## ZINC DUST.

Zinc dust is an impalpable powder which forms in the distillation of zinc when the zinc vapor is cooled too rapidly in the condensers or is diluted by too large a volume of other gas. It may constitute a large proportion of the metallic zinc obtained in electrothermic zinc smelting, but in ordinary retort smelting it usually amounts to between 3 and 10 per cent of the reduced zinc. The powder consists of metallic zinc, with about 10 per cent zinc oxide, which probably exists as a film surrounding the metallic particles. These particles can not be made to coalesce by heating unless under great pressure but must be again vaporized and condensed. Marketable zinc dust must not contain more than 10 per cent of zinc oxide and must pass through a screen of 100 meshes to the inch.

Zinc dust differs from metallic zinc in other physical properties, such as rapid oxidation, absorption of hydrogen, and generally greater chemical activity, resulting at times in spontaneous combustion or explosion. These properties are believed by Sang [1] to be due to conditions of stress resulting from rapid solidification, somewhat analogous to the condition in "Prince Rupert's drops."

These peculiar properties of zinc dust are the cause of many of its uses. Under the name of "indigo auxiliary" a paste of zinc dust is used to discharge locally the color in dyeing cotton goods, giving a white pattern on the background of dye. Zinc dust is used in fireworks and in making hydrogen for balloons. It is the basis of the various methods of dry galvanizing and is also used to furnish the zinc solution in electrozincing. One of the most important uses of zinc dust is as a substitute for zinc shavings in zinc precipitation in the cyanide treatment of gold and silver ores. For this purpose it is cheaper, quicker, more effective, and more convenient than zinc shavings and the saving in cost is about one-third.

In American zinc-smelting practice, heretofore, the zinc dust has been charged back into the retorts, since, under the former tariff, if sold as dust, it came into competition with foreign zinc dust admitted free of duty, whereas recovered as spelter it was protected by an import duty of 1½ cents per pound. Hence the small quantity of zinc dust heretofore used in this country has been imported from Belgium and Germany. The tariff act of 1909, as shown on a later page, established an import duty upon zinc dust of 1⅜ cents per pound.

[1] Sang, Alfred, Old and new methods of galvanizing: Proc. Eng. Soc. Western Pennsylvania, vol. 23, 1907, pp. 546–571.

A new ruling of the Interstate Commerce Commission lists zinc dust and zinc flue dust as inflammable solids and directs that they must bear a yellow shipping label. Paragraph 1834 of the ruling covering this product reads as follows: "Packages must be tight and strong, and the interior packages must be so cushioned and secured that no rupture of either package can result from the ordinary shocks incident to transportation."

The United States Zinc Co. about the middle of 1910 began the preparation of zinc dust for market in the smelter at Pueblo, Colo. Press reports from Denver credit the plant with an initial daily output of 500 pounds of zinc dust which has later doubled in quantity. The market is mainly western, and the product is used for zinc-dust precipitation in cyaniding in South Dakota, Nevada, and elsewhere. The Grasselli Chemical Co., with zinc-smelting plants at Clarksburg and Meadowbrook, W. Va., also prepared zinc dust for market in 1911.

As there are but two producers the quantity and value of the output can not be disclosed, but it has been included in the zinc content of pigments in the following sections. For imports and prices, see under those headings in later sections of this report.

## ZINC PIGMENTS.

There are four white pigments which have zinc for a base, either in whole or in part—zinc oxide, leaded zinc oxide, zinc-lead oxide, and lithopone. All of these may be and in the United States the first three usually are made directly from ore.

Zinc oxide is the most important of these pigments. In European practice the oxide is made from spelter, though in France zinc oxide is made from ore in the electrothermic furnace invented by Côte and Pierron. In the United States the oxide is generally made from ore, but in 1911 of the total production 3,922 tons was made from spelter, as compared with 3,627 tons in 1910. The production of zinc oxide in 1911 may not be disclosed. In 1910 it was 59,333 short tons, as compared with 68,974 tons in 1909 and with 57,237 tons in 1908. The imports for consumption of zinc oxide in 1911 were 2,780 short tons, and the exports for the same period were 14,618 short tons.

Leaded zinc oxide and zinc lead oxide are produced from ore, both in some cases at the same plant, the zinc-lead containing somewhat the larger percentage of lead. No zinc-lead oxide was made in 1910 or 1911. The production of leaded zinc pigment in 1911 may not be disclosed, but in 1910 it was 7,111 short tons.

Lithopone is an intimate mixture by chemical precipitation of zinc sulphide and barium sulphate. It may be manufactured from spelter or zinc oxide, but in the United States it is now generally made from zinc skimmings, ashes, and scrap.

The zinc content of the various zinc pigments made in the United States in 1911 from ore, both domestic and foreign, was 46,376 short tons as compared with 50,660 tons in 1910 and with 54,139 tons in 1909. The quantities given for 1910 and 1911 include the zinc contents of the zinc dust produced during those years, which can not be disclosed separately, there being at present but two producers.

For further details of the production of zinc pigments the reader is referred to the chapter on mineral paints in Part II of Mineral Resources for 1911.

## SECONDARY ZINC.

In the ordinary method of galvanizing, where the material to be coated is dipped into a bath of molten zinc, there is great loss of zinc in the form of semioxidized skimmings and of hard zinc drosses, caused by the alloy formed by the zinc with the iron of the tank and of the article being galvanized. In the larger galvanizing plants there are furnaces to refine these skimmings and drosses and to recover the spelter. There are also many small plants and some large ones which make a practice of buying galvanizers' skimmings and drosses and of recovering the spelter. A considerable quantity of old metal in the form of various alloys of zinc with copper and other metals is also worked over and brought up to the desired composition by the addition of new metal. At almost every brass foundry and machine shop in the country it is the custom to remelt and use brass filings, grindings, and scrap copper and brass, and it is manifestly impracticable to attempt to take full account of such material. Some of the zinc smelters running on ore find it advantageous to work in a quantity of secondary material. In such cases they have made the proper returns to the United States Geological Survey, and account has heretofore been taken of such production in these reports as dross or secondary spelter. As such spelter has been recovered by redistillation, it is practically indistinguishable in quality from spelter of ordinary grades made from ore. Several secondary smelters recovering zinc from drosses do so by redistillation. It has seemed advisable that the secondary spelter recovered by redistillation should be separated from that recovered by remelting and it has accordingly been done in the table below.

The successful operation of an electric furnace for the refining by redistillation of zinc drosses is described in the section on metallurgy on a later page.

Since 1907 statistics have been collected from the secondary smelters and refineries, for the first two years by the writer and since by J. P. Dunlop, of the United States Geological Survey. In 1907 and 1908 reports were obtained from the larger plants only, but in 1909 the scope of the canvass was greatly enlarged, since which time the number of firms has been increased from about 40 to double that number, with a large increase in reported production. The following table gives the production of secondary zinc in the United States, and a later table gives the production of secondary spelter in Europe:

*Production of secondary zinc in 1907–1911, in short tons.*

| | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|
| Secondary spelter, redistilled | 7,050 | 7,159 | 9,273 | 12,784 | 14,043 |
| Secondary spelter, remelted | 11,791 | 9,811 | 23,767 | 28,439 | 26,470 |
| Recovered zinc in alloys, excluding old brass remelted | 1,417 | 665 | 1,181 | 2,709 | 3,223 |
| Recovered zinc in remelted brass | (a) | (a) | 8,204 | 18,450 | 24,110 |
| Secondary zinc recovered as metal | 20,258 | 17,635 | 42,425 | 62,382 | 67,846 |
| Secondary zinc recovered in pigment | 863 | 1,091 | 2,154 | 2,646 | 3,036 |
| Secondary zinc recovered in zinc chloride [b] | 4,411 | 4,500 | 3,839 | 3,970 | 3,865 |
| Total secondary zinc | 25,532 | 23,226 | 48,418 | 68,998 | 74,747 |

[a] Statistics not collected.

[b] These figures include only the quantity of zinc in zinc chloride used in wood preservation treatment, and were furnished by courtesy of the Forest Service, Department of Agriculture.

Besides the increased recovery of secondary zinc as spelter and in alloys as shown in this table, there was increased use of zinc skimmings and drosses in the manufacture of zinc pigments and lithopone and about the same quantity in zinc chloride. The zinc content of pigments and lithopone made from secondary zinc in 1911 was 3,036 tons, as compared with 2,646 tons in 1910. The zinc content of zinc chloride manufactured from secondary zinc and used in the treatment of railroad ties, bridge timbers, etc., in 1911, is estimated at 3,865 tons, as against 3,970 tons in 1910.

E. W. Peters[1] has studied the benefits of the use of wood preservatives in mine timbers, and has made certain comparisons as to the relative cost and value of zinc chloride and creosote as preservatives. The following conclusions may be quoted here:

1. Decay is, in general, the agency most destructive to timber used in mines.
2. Although decay may often be retarded by peeling and seasoning, treatment with a suitable preservative is more effective.
3. The average life of green, unpeeled, and untreated loblolly pine gangway sets, under the conditions of the experiments discussed, was less than one and one-half years. Brush treatments with creosote and carbolineum increased this to three and four years, while impregnation treatments with zinc chloride and creosote left from 70 to 90 per cent of the timbers sound at the end of four years.
4. The use of treated timber results in a saving in the cost of maintenance of workings and a reduction in the amount of timber required and makes possible the utilization of inferior species of wood.
5. Brush treatments are economical when the amount of timber to be treated will not warrant the erection of a small open-tank or pressure plant, or when only a short increase in service is required.
6. The open-tank process is adapted to the treatment of small quantities of easily impregnated timber. When a large amount of material is to be treated, a pressure process should be used.
7. Mine timbers impregnated with zinc chloride and creosote oils have shown the best results. Up to the present, no difference in their durability has been noted.

As to cost of treatment, the differential is in favor of the zinc chloride. The Philadelphia & Reading Coal & Iron Co. found[2] the cost of sufficient zinc chloride to treat a set of timbers to be $0.52 as compared with $2.40, the cost of creosote. The expense of treatment being the same in each case, the total cost per set of treated timber installed in the mines was found to be $9.96 for the set treated with zinc as against $11.84 for the set treated with creosote.

The exports of zinc dross continue to decrease. They were 4,246 short tons in 1911 as compared with 4,724 tons in 1910, with 7,069 tons in 1909, with 8,405 tons in 1908, with 9,593 tons in 1907, and with 15,887 tons in 1906, thus supplementing the figures of increased recovery of secondary zinc. It is to be expected that exports of zinc dross will cease altogether in time, as the zinc content is normally worth more in this country than abroad because of the import duty on zinc.

[1] Peters, E. W., The preservation of mine timbers: Bull. U. S. Forest Service No. 107, 1912, p. 23.
[2] Idem, p. 15.

## COMPARISON OF STATE TOTALS, BASED ON SMELTER AND ON MINE REPORTS.

The foregoing figures of the production of spelter by the respective States are compiled from reports from individual zinc smelters. For several years the production of the more valuable metals in the Western States has been also obtained by the United States Geological Survey from reports of individual mines, and since 1907 this has been extended over the whole country. In order to put the spelter production on the same basis as the mine figures, all the zinc which is manufactured into pigment directly from ore (excluding the quantity in zinc oxide manufactured from spelter, the inclusion of which would entail its duplication in the totals) is added to the production of metallic zinc. The zinc dust recovered during the year is also included here. The zinc recovered from secondary sources is excluded, since it has already been once reckoned as spelter. These facts must be borne in mind in comparing this table with the table showing the production of spelter. The State totals obtained by each method are compared in the following table:

*Comparison of State totals of production of zinc, 1908–1911, based on smelter and mine reports, in short tons.*

| State. | 1908 | | | | 1909 | | | |
|---|---|---|---|---|---|---|---|---|
| | Totals based on smelter reports. | Totals estimated from mine reports. | Differences. | | Totals based on smelter reports. | Totals estimated from mine reports. | Differences. | |
| | | | Smelter excess. | Mine excess. | | | Smelter excess. | Mine excess. |
| Arizona | 152 | 339 | ..... | 187 | 2,862 | 2,989 | ..... | 127 |
| Arkansas | 2,002 | 605 | 1,397 | ..... | 135 | 510 | ..... | 375 |
| California | 27 | 0 | 27 | ..... | 0 | 0 | ..... | ..... |
| Colorado | 29,907 | 15,065 | 14,842 | ..... | 23,374 | 25,605 | ..... | 2,231 |
| Idaho | 581 | 19 | 562 | ..... | 901 | 676 | 225 | ..... |
| Illinois | 298 | 1,717 | ..... | 1,419 | 675 | 2,163 | ..... | 1,488 |
| Iowa | 516 | 395 | 121 | ..... | 0 | 35 | ..... | 35 |
| Kansas | 8,628 | 14,119 | ..... | 5,491 | 9,185 | 11,445 | ..... | 2,260 |
| Kentucky | 341 | 0 | 341 | ..... | 22 | 56 | ..... | 34 |
| Missouri | 123,655 | 107,404 | 16,251 | ..... | 140,811 | 130,162 | 10,649 | ..... |
| Montana | 900 | 820 | 80 | ..... | 4,725 | 4,680 | 45 | ..... |
| Nevada | 398 | 558 | ..... | 160 | 825 | 1,507 | ..... | 682 |
| New Jersey | 47,643 | 67,165 | ..... | 19,522 | 63,307 | 82,510 | ..... | 19,203 |
| New Mexico | 616 | 1,788 | ..... | 1,172 | 5,216 | 6,543 | ..... | 1,327 |
| Oklahoma | 2,235 | 4,529 | ..... | 2,294 | 3,008 | 7,806 | ..... | 4,798 |
| Tennessee | 341 | 344 | ..... | 3 | 695 | 596 | 99 | ..... |
| Texas | 0 | 18 | ..... | 18 | 0 | 0 | ..... | ..... |
| Utah | 282 | 730 | ..... | 448 | 5,960 | 4,930 | 1,030 | ..... |
| Virginia | 910 | 705 | 205 | ..... | 58 | 58 | ..... | ..... |
| Wisconsin | 18,598 | 18,206 | 392 | ..... | 21,414 | 23,152 | ..... | 1,738 |
| Total | 238,030 | 234,526 | ..... | ..... | 283,173 | 305,423 | ..... | ..... |

*Comparison of State totals of production of zinc, 1908–1911, based on smelter and mine reports, in short tons*—Continued.

| State. | 1910 | | | | 1911 | | | |
|---|---|---|---|---|---|---|---|---|
| | Totals based on smelter reports. | Totals estimated from mine reports. | Differences. | | Totals based on smelter reports. | Totals estimated from mine reports. | Differences. | |
| | | | Smelter excess. | Mine excess. | | | Smelter excess. | Mine excess. |
| Arizona | 2,594 | 2,742 | ..... | 148 | 2,476 | 2,281 | 195 | ..... |
| Arkansas | 286 | 994 | ..... | 708 | 385 | 664 | ..... | 279 |
| California | 0 | 0 | ..... | ..... | 959 | 1,404 | ..... | 445 |
| Colorado | 25,883 | 38,545 | ..... | 12,662 | 45,093 | 47,304 | ..... | 2,211 |
| Idaho | 3,454 | 2,802 | 652 | ..... | 3,180 | 4,170 | ..... | 990 |
| Illinois | 1,551 | 3,549 | ..... | 1,998 | 2,884 | 4,219 | ..... | 1,335 |
| Iowa | 40 | 96 | ..... | 56 | ..... | ..... | ..... | ..... |
| Kansas | 10,220 | 13,229 | ..... | 3,009 | 6,843 | 10,272 | ..... | 3,429 |
| Kentucky | 29 | 6 | 23 | ..... | 205 | 158 | 47 | ..... |
| Missouri | 140,653 | 128,589 | 12,064 | ..... | 127,601 | 122,515 | 5,086 | ..... |
| Montana | 12,417 | 15,819 | ..... | 3,402 | 22,115 | 21,905 | 210 | ..... |
| Nevada | 1,551 | 1,354 | 197 | ..... | 1,618 | 1,774 | ..... | 156 |
| New Jersey | 65,419 | 68,678 | ..... | 3,259 | 53,413 | 77,445 | ..... | 24,032 |
| New Mexico | 5,889 | 9,044 | ..... | 3,155 | 3,813 | 5,119 | ..... | 1,306 |
| Oklahoma | 2,297 | 6,394 | ..... | 4,097 | 2,247 | 5,150 | ..... | 2,903 |
| Tennessee | 925 | 966 | ..... | 41 | 1,000 | 1,117 | ..... | 117 |
| Utah | 7,288 | 8,184 | ..... | 896 | 7,512 | 8,920 | ..... | 1,408 |
| Virginia | 1,168 | 794 | 374 | ..... | 314 | [a] 1,113 | ..... | 799 |
| Washington | ..... | ..... | ..... | ..... | 12 | 10 | 2 | ..... |
| Wisconsin | 21,475 | 25,927 | ..... | 4,452 | 33,359 | 29,720 | 3,639 | ..... |
| Total | 303,139 | 327,712 | ..... | ..... | 315,029 | 345,260 | ..... | ..... |

[a] Includes a small quantity of zinc from New York.

The smelter State totals represent actual recovery and are found by summing up the total production reported by all companies for each State, respectively, all pigments being recalculated back to equivalent metallic zinc on the basis of average analysis of product. In compiling the mine totals each producing property is requested to report actual tonnage of zinc ores and concentrates shipped, and from this the zinc content is reckoned by assay value. From that zinc content 10 to 20 per cent, according to the character of the ore, is deducted for smelting losses, and the remainders thus obtained from all the producing properties in each State are combined to afford the totals for the respective States. Where the ore is concentrated at a custom mill, proper allowance is also made for the loss of metal in the process. It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from each producing mine and smelter. It is further essential to the correctness of the mine totals that the assay content and the theoretical recovery be correctly estimated. Theoretically, the State totals, as compiled from smelter reports and from mine reports, respectively, should in the long run agree closely. As a matter of fact, for any year they show considerable divergence. These discrepancies, giving rise to "smelter excess" or "mine excess," may be the result of one cause or of a combination of causes, among which are: Lag in the smelting of the ore, resulting in accumulation of ore stocks at the smelters; lag in the mining, owing to which the smelter depletes its ore stocks; error in calculating metallic content from assay and in estimating recovery; and error by smelters in exact distribution of spelter, by States, according to source.

Of these sources, the greater discrepancies arise from erroneous distribution by the smelters, in particular as among the States in the

Joplin region and in the upper Mississippi Valley region. Smelters using ore from the Joplin region are prone to credit it to Missouri because bought through their agents at Joplin. Similarly, in the upper Mississippi region the ore is likely to be credited to Wisconsin because bought through a Wisconsin buyer. In each region there are companies operating in more than one State but selling ore through a central office—a condition which likewise leads to error in distribution. Another cause for such error, particularly in the upper Mississippi region, is found in the electrostatic and electromagnetic separation plants, the ore from which is naturally credited to the State in which the plant is located.

The smelter reports give the exact annual production of zinc and serve as a check on the mine production, and they also give the form in which the zinc was recovered, whether as spelter or as pigment. The distribution among States by the smelter reports has value as a check on the mine State totals, and also because of the earlier publication, but for exact distribution of zinc production according to origin, recourse must be had to the mine production reports.

### MINE AND SMELTER TOTALS, 1911.

The mine excess in Arkansas is due in part to erroneous distribution by smelters, ore from that State being probably attributed to Missouri. The mine excess in California is probably due to lag in smelting, as would naturally be expected in the case of a State just beginning zinc production. The mine excess in Colorado is very probably due to lag, as it is known that there are large stocks of zinc ore derived from Colorado now in the hands of smelting companies. The mine excess in Idaho, following four successive smelter excesses, probably represents the replenishment of depleted smelter stocks. The mine excess in Illinois is due to error in distribution by smelters, for which there are several causes, as outlined in the preceding page. The similar mine excesses in Kansas and Oklahoma are due to similar causes, the spelter made from ore from those States being credited to Missouri, which more than accounts for the large smelter excess in that State. The mine excess in New Jersey is partly accounted for by the zinc content of the 18,281 short tons of exported willemite ore. The mine excess in New Mexico, being the fourth successive mine excess, must be due to error, probably error in distribution by the smelters. The mine excesses in Utah and Virginia seem explicable as due to lag, and it is noted on a later page that some Utah zinc concentrates were held for a better price. The smelter excess in Wisconsin largely accounts for the mine excess in 1910.

## RESOURCES.

### UNITED STATES

#### MINE PRODUCTION OF ZINC.

The following table shows, for each zinc-producing State, the total quantity of zinc ore produced, and the output of each kind of zinc ore. The column headed "All other ore" includes lead ore, copper ore, copper-lead ore, and dry or siliceous ore, no zinc of consequence being recovered from any of these except in Colorado. "Dry" ores produced in that State in 1911 contained 2,497 short

tons of recoverable zinc. The total crude ore yielding either gold, silver, copper, lead, or zinc is given for each zinc-producing State, so that a comparison may be made of the relative extent of deep mining operations for all five metals in these States, the amount of crude ore raised being the best measure for this purpose. The table discloses the fact that Missouri made nearly one-third of the crude ore production of the zinc-producing States, having an output of 12,136,788 short tons of crude ore, of which 8,162,076 tons was zinc bearing. Excluding iron ore, this was the largest production of metalliferous crude ore in the United States. Next in rank was Michigan, with 10,978,827 tons of crude copper ore.

The table gives also the quantity of recoverable zinc contained in the crude ores of each State and the quantity of zinc recovered from each kind of zinc ore. The percentage of recoverable zinc contained in the zinc ore and the zinc-lead ore of each State is also shown. The recoverable zinc content of crude zinc ore ranges from 31.7 per cent in Nevada down to 1.5 per cent in Missouri, the Western States having uniformly the higher percentage. The average recoverable zinc content of the zinc ore of the United States in 1911 was 2.7 per cent. Of the total mine production of zinc in 1911, a quantity corresponding to 89.5 per cent was derived from zinc ore, 9.8 per cent was derived from zinc-lead ore, and 0.7 per cent was recovered from all other ores. The figures of mine production of zinc are taken from the chapters on gold, silver, copper, lead. and zinc (mine production) in the various States appearing elsewhere in this volume.

*Source of mine production of zinc in 1911, by States and kinds of ore, in short tons.*

| States. | Zinc ore. | | | Zinc-lead ore. | | | All other ore. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Crude ore. | Recoverable zinc content. | Per cent. | Crude ore. | Recoverable zinc content. | Per cent. | Crude ore. | Recoverable zinc content. | Crude ore. | Recoverable zinc content. |
| Arizona | 16,106 | 1,797 | 11.2 | 10,756 | 480 | 4.5 | 4,540,277 | 4 | 4,567,139 | 2,281 |
| Arkansas | 24,925 | 664 | 2.7 | ..... | ..... | ..... | ..... | ..... | 24,925 | 664 |
| California | 4,625 | 1,404 | 30.4 | ..... | ..... | ..... | 2,939,563 | ..... | 2,944,188 | 1,404 |
| Colorado | 110,845 | 25,695 | 23.2 | 214,385 | 19,112 | 8.9 | 2,052,706 | 2,497 | 2,377,936 | 47,304 |
| Idaho | 51,050 | 3,311 | 6.5 | 397,354 | 859 | 0.2 | 1,722,493 | ..... | 2,170,897 | 4,170 |
| Illinois | [a] 153,313 | 4,219 | 2.8 | ..... | ..... | ..... | ..... | ..... | [a] 153,313 | 4,219 |
| Kansas | 761,465 | 10,272 | 1.3 | ..... | ..... | ..... | ..... | ..... | 761,465 | 10,272 |
| Kentucky | [b] 5,000 | 158 | 3.2 | ..... | ..... | ..... | ..... | ..... | [b] 5,000 | 158 |
| Missouri | 8,162,076 | 122,515 | 1.5 | ..... | ..... | ..... | 3,974,712 | ..... | 12,136,788 | 122,515 |
| Montana | 225,586 | 21,867 | 9.7 | 128 | 38 | 29.7 | 4,714,589 | ..... | 4,940,303 | 21,905 |
| Nevada | 3,013 | 975 | 31.7 | 4,654 | 799 | 17.2 | 4,125,054 | ..... | 4,132,721 | 1,774 |
| New Jersey | 374,064 | 77,445 | 20.7 | ..... | ..... | ..... | ..... | ..... | 374,064 | 77,445 |
| New Mexico | 8,402 | 1,102 | 13.1 | 16,333 | 4,017 | 24.6 | 207,964 | ..... | 232,699 | 5,119 |
| Oklahoma | 224,450 | 5,150 | 2.3 | ..... | ..... | ..... | ..... | ..... | 224,450 | 5,150 |
| Tennessee | 22,564 | 1,117 | 5.0 | ..... | ..... | ..... | 581,974 | ..... | 604,538 | 1,117 |
| Utah | 5,753 | 582 | 10.1 | 280,817 | 8,338 | 3.0 | 6,981,960 | ..... | 7,268,530 | 8,920 |
| Virginia | [c] 16,704 | 1,113 | 6.7 | ..... | ..... | ..... | ..... | ..... | [c] 16,704 | 1,113 |
| Washington | ..... | ..... | ..... | 51 | 10 | 19.6 | 82,254 | ..... | 82,305 | 10 |
| Wisconsin | 1,123,040 | 29,720 | 2.6 | ..... | ..... | ..... | ..... | ..... | 1,123,040 | 29,720 |
| Total | 11,292,981 | 309,106 | 2.7 | 924,478 | 33,653 | 3.6 | 31,923,546 | 2,501 | 44,141,005 | 345,260 |
| Per cent of total zinc derived from each kind of ore | 89.5 | | | 9.8 | | | 0. | | 100.0 | |

[a] Exclusive of fluorspar ore mined in southern Illinois.
[b] Estimated.
[c] Includes also a little lead and zinc ore from New York.

## BRIEF REVIEW OF ZINC-PRODUCING DISTRICTS.

For details of production in the various zinc-producing districts of the country the reader is referred to the mine reports for the individual States, which appear elsewhere in this volume. This review is based on those reports or on notes furnished by the authors of the various reports. Only the general trend of development during the year will be here noticed in connection with the different districts.

### EASTERN STATES.

New York became a producer of lead and zinc for the first time in several years. In St. Lawrence County a small shipment of lead ore was made from a vein near Gouverneur, and near Edwards the Northern Ore Co. developed a deposit of blende and pyrite and shipped to smelters a small tonnage of crude zinc ore. A 50-ton concentrator was in course of construction at the close of the year. Both zinc blende and pyrite will be marketed.

The chief zinc-producing district in the eastern part of the United States is the famous Franklin Furnace region of New Jersey, embracing the great zinc deposits of Sterling Hill and Mine Hill. The former was mined continuously from about 1875 until 1900, and the latter is making near its maximum yield after over 60 years of active mining. The production in 1911 was almost exactly the same as in 1910. Some diamond drilling was done at the Sterling Hill mine, and that mine will probably be reopened.

The Virginia-Tennessee area is the only other prominent zinc-producing region in the eastern part of the United States. The Virginia zinc mines made a larger output in 1911 than for several years, but it was mostly from tailings. The zinc carbonate and blende deposits of eastern Tennessee assumed considerable importance in 1909 and 1910, owing to the reopening of some old mines and the entry into the district of the Grasselli Chemical Co., which obtained control of several productive properties. In 1911 the American Zinc Co. of Tennessee, a subsidiary of the American Zinc, Lead & Smelting Co., took over the Holston mine at Mascot as well as other properties and by the close of the year had sunk the Mascot shaft to a depth of about 400 feet. The shaft will be continued to a depth of 1,000 feet and a 1,000-ton mill is under construction.

### CENTRAL STATES.

The upper Mississippi Valley region, embracing the adjoining productive areas of Wisconsin, Illinois, and Iowa, made a fair gain in production of zinc concentrates over that of 1910. The gain made by Wisconsin was largely due to the greater output of the Benton district, which turned out nearly a third of the State product. The Galena district in Illinois also made a gain. The electrostatic plant of the American Zinc Ore Separating Co., at Platteville, Wis., and the rotary magnetic plant of the Joplin Separating Co., at Galena, were destroyed by fire late in the year, but the latter plant will be rebuilt and enlarged.

In the Kentucky-Illinois district a number of promising prospects were opened, from one of which several hundred tons of zinc carbonate were shipped. For several years prior to 1911 Kentucky has had

no important output of zinc, for which condition two things are responsible, the difficulty of separating the zinc from the fluorspar with which it is generally associated and the stagnation in the fluorspar industry.

The Joplin region, embracing southwestern Missouri, southeastern Kansas, and northeastern Oklahoma, showed a loss of 7.5 per cent in zinc produced, as compared with the output of 1910. This was owing to the continued idleness of many of the sheet-ground mines of the Webb City district of Missouri, which shut down in 1910 on account of low ore prices, though both Kansas and Oklahoma show considerable loss in zinc produced as compared with 1910. The loss in the sheet-ground district was just about made up by the large output of the soft-ground mines of the new Thoms Station district north of Joplin. The improvement in ore prices during the latter half of the year led to the reopening of many of the sheet-ground mines, so that in 1912 they will probably have a normal production. In Kansas developments at Lawton and south of the Badger district as well as the renewal of old mining tracts about Galena offer the promise of larger production. In Oklahoma the deeper deposits at Miami are turning out well, and the higher ore prices have encouraged further operations at Quapaw.

Arkansas zinc production fell off just one-third, owing to the enforced idleness due to litigation, during the part first of the year, of the largest producer. The largest mill in the State was erected at the Morning Star mine, and extensive developments were made at the Philadelphia mine, so that 1912 should see an improvement in the production for the district.

The production of the Arbuckle Mountain region of Oklahoma remained about stationary, but developments were continued.

### WESTERN STATES.

New Mexico decreased heavily in zinc production, the loss being over 40 per cent. The zinc-producing mines in 1911 were at Kelly, in the Magdalena district, Socorro County, and in the Pinos Altos and Central districts of Grant County.

Colorado's zinc production increased nearly one-fourth over that of 1910. Of the total, Lake County, including the Leadville district, produced 76 per cent. The output of zinc-carbonate ore increased from 8,059 tons in 1910 to 83,905 tons in 1911. This ore in 1910 was discovered to exist in large quantities in the old upper stopes formerly worked for lead carbonate and the sulphides. The high price of zinc in the latter part of 1911 led to great activity in the deposits of zinc carbonate to the neglect of the sulphides. The output of the latter fell off considerably, but partly on account of the closing of the Leadville mill of the American Zinc Extraction Co. at the mouth of the Yak tunnel. If the plan, now being formulated, to drain the Downtown district of Leadville by electric pumps is carried out, a large territory productive of zinc-carbonate ores will undoubtedly be opened.

Montana made a substantial increase in zinc from 15,819 tons in 1910 to 21,905 tons in 1911, having risen to this point from a production of about 100 tons in 1907. The increase in 1911 was due to better methods of concentration at the Basin works, leased by the

Butte-Superior Co. to treat ore from the Black Rock mine at Butte, where 450 tons of ore were concentrated daily during 1911. The new 1,000-ton mill under construction at the mine of the Butte-Superior is described elsewhere in this report. The Elm Orlu lost its 350-ton concentrating plant, the Butte Reduction Works, by fire in October. Zinc concentrates from the Butte mines averaged 50 per cent of zinc and were concentrated from an ore averaging approximately 22.5 per cent of zinc.

In Idaho great gains have been made in the last few years in zinc from the mines in the Cœur d'Alene district of Shoshone County, which with Blaine County produced 4,170 tons of zinc in 1911, as compared with 2,802 tons in 1910, an increase of nearly 50 per cent. Zinc ore and lead-zinc ore was mined in seven properties of the Cœur d'Alene district. New concentrating equipment was added to the Success mill, the principal producer, and at the Morning mill the Macquisten flotation process was so successful in the recovery of zinc from blende-barite-siderite middlings that the flotation plant will be doubled in capacity.

Utah produced a slightly increased quantity of zinc, aggregating 8,920 tons, as against 8,184 tons in 1910. The output credited to the Daly-Judge mine in Wasatch County was less, owing to the reserve dump of zinc middlings having been entirely reconcentrated at the dry mill of the Grasselli Chemical Co. A large part of the new concentrate produced at the Daly-Judge mill was held for a better market. The Beaver County mines were inactive. Tooele County mines yielded an increased quantity from mines in the North Tintic district. Next in importance was the output of the Bingham mines in Salt Lake County.

Arizona mines had a somewhat smaller zinc production in 1911 than in 1910, the figures being 2,281 tons and 2,742 tons, respectively. Less zinc was produced in Mohave County than formerly. Cochise, Santa Cruz, and Yavapai counties were also producers. The new concentrator at the Needles, Cal., smelter went into operation during the year. It is equipped with Huff electrostatic separating machines.

Nevada's zinc output increased from 1,354 tons in 1910 to 1,774 tons in 1911. The output is almost altogether from Clark County and the gain was largely due to the new 60-ton concentration mill at the Yellow Pine mine. A new branch railroad connecting Goodsprings with the main line at Jean was finished during the year. The zinc ores are the oxidized forms, carbonates and silicates, with which occur lead carbonate, lead sulphide, and silver.

California had some production of zinc in 1907 and 1908, and a small quantity also in 1910, but the State has never been an extensive producer of the metal. The largest production ever made was in 1911, when the output reached 1,115 tons, almost altogether from Inyo County but with a small quantity from San Bernardino County. Most of the ore from which this metal was derived came from the old Cerro Gordo lead and silver mine in Inyo County. The ore so far shipped is the carbonate, running from 32 to 37 per cent zinc. Experiments are being continued at the Bully Hill copper mine, in Shasta County, with a view of utilizing the zinc ores found there, but thus far no production of this metal has been made.

Washington's production of zinc in 1911, the yield of the Oriole mine in the Metaline district of Pend Oreille County, was the first

shipment to be recorded from that State. The ore was a sulphide with a siliceous gangue carrying gold, silver, lead, and a small quantity of copper.

### MEXICO.

Zinc deposits are found in the Mexican States of Tamaulipas, Nuevo Leon, San Luis Potosi, Coahuila, and Chihuahua, but most of the ore imported into the United States has come from the two last mentioned.

Accurate figures of imports of zinc ore from Mexico are only to be had for the period since the tariff act of 1909 imposed a duty upon Mexican ore based upon the zinc content, thereby necessitating accurate weights and assays of the ore. The imports of zinc ore from Mexico in 1911 were 75,982 short tons, containing 30,693 tons of zinc, as compared with 82,657 tons, containing 40,434 tons of zinc in 1910, a falling off of 8 per cent in quantity of ore and of 24 per cent in zinc content, showing that the ore now imported is lower in grade than that imported in 1910. The ore for 1911 averaged approximately 40 per cent of zinc; that for 1910 averaged nearly 50 per cent of zinc. That the quantity of ore imported was not so great as in 1910 is doubtless due to the insurrection in Mexico. On account of the high price of spelter in the latter part of 1911, the lower grade ore previously unavailable on account of the tariff levied by the United States could be profitably mined and exported.

Certain changes in the Mexican railway tariffs, possibly designed in retaliation for the United States import duty, became effective at the beginning of the year. The new schedule increased the rate from the zinc districts of northern Mexico to the United States $1.08 per ton and lowered that to Gulf ports $0.27 per ton. The difference in freight rates added to the United States import duty led to the consignment of several experimental lots of zinc ore to European smelters in the early part of 1910, but as yet no satisfactory arrangements have been made for continuous shipments on a large scale.

### CANADA.

The imports of zinc ore from Canada fell away from 10,024 short tons in 1909 to 4,749 tons in 1910 and 2,359 tons in 1911. This decrease was at first due probably to the tariff on zinc ore and to the low price of spelter in 1910. The decrease during the latter part of the period in the face of the prevailing high prices for spelter is to be attributed to the forest fires in British Columbia, which destroyed concentrating mills and transportation facilities.

The zinc ore produced in British Columbia now finds its way to the zinc smelters of the United States. In the past the output of these ores has not assumed great importance, but there is no doubt of their extended occurrence, and should commercial success attend the efforts at reduction the district would become an important zinc producer.

A strong endeavor is being made in the Dominion of Canada to develop a commercially successful method of reducing the complex zinc ores of the Kootenay district of British Columbia. The Dominion Government appropriated $50,000 for experimental work, a preliminary report upon which is summarized in a later section on metallurgy.

## AUSTRALIA.

The principal source of zinc in Australia is the silver-lead mines of Broken Hill, New South Wales. In the early days of Broken Hill mining the crude ore ran about 25 per cent each in lead and zinc and 25 ounces in silver, but by 1904 the average tenor had become reduced to 16 per cent each of lead and zinc with 11 ounces of silver to the ton. At present the average tenor is probably somewhat below those figures. In the effort to get rid of the zinc it was heaped up in enormous piles of zinc tailings and slimes from the concentrating plants, and lead concentrates with 20 per cent of zinc were smelted, lead slags averaging 16 per cent of zinc oxide with a maximum of 20 per cent having been run, according to Donald Clark.[1] Various leaching, electrolytic, and magnetic processes were successively tried and finally discarded for the flotation processes which have been in practical use since 1903. This method of concentration has the advantage that it can be applied to the current output of zinc tailings and slimes as well as to the accumulated stocks of those products.

The importance of flotation in that country is shown in the following table of the production of zinc concentrates at Broken Hill by flotation methods for the period 1907–1911, compiled from the annual reports of the department of mines of New South Wales. These concentrates are recovered from zinc middlings and tailings, both from the current product and from the stored accumulations of bygone years of milling operations. The minor quantities of lead concentrates recovered, as a table product from the zinc concentrates, are not included:

*Production of zinc concentrates at Broken Hill, New South Wales, 1908–1911, in long tons.*

| Company. | Flotation process used. | 1909 | | 1910 | | 1911 | |
|---|---|---|---|---|---|---|---|
| | | Tailings treated. | Concentrates. | Tailings treated. | Concentrates. | Tailings treated. | Concentrates. |
| Sulphide Corporation | Ballot | ..... | 92,408 | ..... | 80,491 | ..... | 78,822 |
| Broken Hill Proprietary | Potter | 171,172 | 52,042 | 279,150 | 69,855 | 422,511 | 103,378 |
| Zinc Corporation | Ballot | 227,502 | 84,698 | 270,637 | 85,625 | 331,486 | 103,630 |
| Minerals Separation | do | 193,842 | 62,022 | 240,143 | 79,288 | 105,297 | 33,058 |
| Amalgamated Zinc (De Bavay's) | De Bavay | 98,669 | 30,146 | 280,394 | 82,697 | 542,015 | 159,133 |
| British Broken Hill | Elmore | ..... | ..... | 33,428 | 9,622 | ..... | 24,679 |
| Broken Hill Block 10 | do | ..... | ..... | 3,300 | 965 | ..... | ..... |
| Total concentrates produced. | | ..... | 321,316 | ..... | 397,866 | ..... | 502,700 |
| Average zinc content, per cent. | | ..... | 45 | ..... | 47.2 | ..... | 46 |

In 1903 the department of mines of New South Wales estimated the tonnage of stored zinc tailings and other zincky residues at 5,687,400 long tons, containing an average of 18.6 per cent of zinc. In 1908 the stocks of zinc tailings were estimated by different authorities to amount to about 7,000,000 tons and to contain about 1,200,000 long tons of zinc, 350,000 tons of lead, and 40,000,000 ounces of silver. A correspondent of the Australian Mining Standard of April 6, 1910, puts the stock of tailings at 6,000,000 tons, the total capacity of the flotation plants when present plans are completed at about

[1] Clark, Donald, Australian mining and metallurgy, Melbourne, 1904, p. 372.

31,000 tons weekly, and the current production of zinc tailings at 24,000 tons weekly. At this rate of excess of consumption over current production it would require about 16 years for the re-treatment plants to absorb the accumulated tailings. This estimate is contingent upon the continuation in the future of the present rate of production of the mines.

The following table compiled from the annual reports of the department of mines of New South Wales shows the quantity and zinc content of zinc concentrates exported from New South Wales from 1904 to 1911:

*Exports of zinc (spelter and concentrates) from New South Wales, 1904–1911, in short tons.*

| Year. | Concentrates. | Zinc content. | Year. | Concentrates. | Zinc content. |
|---|---|---|---|---|---|
| 1904 | 64,514 | 24,996 | 1908 | 309,044 | 127,515 |
| 1905 | 115,956 | 34,313 | 1909 | 418,775 | 161,300 |
| 1906 | 114,984 | 37,438 | 1910 | 524,862 | 207,085 |
| 1907 | 264,601 | 85,842 | 1911 | 578,343 | 213,321 |

## METALLURGY.

### CONCENTRATION AND SEPARATION.

A brief description of various ore flotation processes was given in Part I of Mineral Resources for 1908, pages 251–256, and to that summary the reader is referred for further information.

The Macquisten flotation plant installed in 1910 at the Morning mill of the Federal Mining & Smelting Co., at Mullan, Idaho, to treat zinc-barite-siderite middlings from the tables and vanners has been doubled in capacity. Originally consisting of 120 Macquisten tubes, a second unit, to utilize 128 tubes, was begun near the close of the year, and this when completed will more than double the capacity of the plant and enable it to handle 200 tons of feed per day.

A concentration plant of 40 tons capacity is under construction near Park City, Utah, to re-treat tailings from that district to recover their lead and zinc content. Wilfley tables and Macquisten flotation tubes are to be installed.

The complex nature of the zinc ores of the Butte district has made their successful concentration very difficult. The Butte & Superior Co., after adequate tests, decided to install the Hyde flotation process in the new concentrating plant to be erected at the mine during 1911–12. The essentials of the process as given herewith are furnished by the patent specifications (U. S. patent No. 922085):

The pulp is mixed with acid before thickening in a tank. It has been found that adding the acid in advance cuts down the amount required and promotes the settlement of colloidal material, which may be further aided, if necessary, by adding copperas, alum, or some other coagulant. From the thickener the pulp is pumped to the first-treatment tank, where oil is added and the entire mass agitated. A float concentrate is then taken off, and the gangue goes to the second-treatment tank, where the process is repeated, and thence to the third-treatment tank, where the pulp is agitated and a third concentrate taken off. From this tank the gangue is discharged as a final tailing.

There is considerable silica mixed with the first concentrates, so they are all recleaned in a second device, the concentrates from which are the final product, while the tailing is all sent back through the system again.

The results of operation of the process are given in the Engineering and Mining Journal[1] for June 1, 1912, from which are taken the following notes regarding the concentration plant. The plant will consist of two units, each of 500 tons capacity and each equipped with crushing plant, jigs, hydraulic classifiers, a slime plant for oil flotation, and Wilfley tables, which are used only to separate the lead from the zinc. The ore is first reduced by rolls to six mesh, and after jigging the tailings are reground to 40 mesh and the tailings from the fine jigs ground to 100 mesh and treated by oil flotation. The pulp is thickened to three parts water and one part ore and is mixed with a small quantity of oil and sulphuric acid and agitated.

It is reported that all available zinciferous dumps and tailing piles in the Butte district are under lease to be worked by the Hyde process.

The electrostatic separating plant of the American Zinc Ore Separating Co., at Platteville, Wis., the first commercial plant using the Huff electrostatic machines, was destroyed by fire late in the year. Other electrostatic zinc-separating plants controlled by the same company are in operation at Sunnyside, near Silverton, Colo.; at Midvale, Utah; and at Needles, Cal.

## SMELTING.

### CHEMICAL AND ELECTROCHEMICAL REDUCTION.

The French Complex Ores Reduction Co. is operating, at Nelson, British Columbia, an experimental plant, trying out the process of ore reduction devised by A. Gordon French, which is thus described by the inventor:[2]

> The ore is crushed to pass one-twelfth of an inch mesh. Concentrates may be taken as they come from the mill and passed through a calcining furnace until almost sweet, and while still hot and in the furnace about 4 to 5 per cent of bisulphate of sodium, ordinary niter cake, which is a cheap waste product from sulphuric and nitric-acid manufacture, is mixed with the charge and after a few minutes the ore is withdrawn and allowed to cool. It is then transferred to leaching tanks and water slightly acidulated with a little niter cake is allowed to percolate through it. This dissolves all the zinc and manganese and leaves the whole of the lead, silver, iron, etc., in the residue in condition to be sent to the smelters. The zinc and manganese solution, which is very strong, is run into electrolytic tanks, where the former metal is deposited on the cathode plates as clean, pure spelter, and the latter as manganese dioxide on the anode plates. An important part of the process is this perfect separation of the zinc from the manganese. The manganese dioxide has a ready market and fetches a good price.
>
> The bisulphate of sodium used in the calcining and leaching operations is regenerated in the electrolytic tanks and goes round in a cycle so that very little requires to be bought, and, being a waste article, its first cost is very low.

### ELECTROTHERMIC ZINC SMELTING.

The experimental work authorized by the Government of the Dominion of Canada in the hope of finding a reduction process for the complex zinc sulphide ores of British Columbia is proceeding at McGill University, Montreal, by Dr. Alfred Stansfield. A preliminary

[1] Eng. and Min. Jour., vol. 93, June 1, 1912, p. 1068.
[2] British Columbia Min. and Eng. Record, May, 1912, p. 299. Quoted from Nelson (B. C.) News.

report by W. R. Ingalls, the consulting engineer, may be abstracted as follows:[1]

A large number of experiments have been made with several forms of furnaces, certain of which have been of rather elaborate construction, and with a variety of raw material.

Our early experiments were directed chiefly toward a discovery of the metallurgical conditions that have heretofore prevented a satisfactory condensation of zinc as molten spelter. While I can not say that these experiments have afforded us a complete explanation of these conditions, they have taught us a good deal, but in spite of the knowledge acquired, we have been so far unable to master the difficulties.

We have, indeed, produced some small quantities of spelter, and in certain experiments have condensed a fairly large proportion as molten metal, but we have not yet been able to do that at will.

Our experiments have thrown light upon the principles of furnace design and have led us to condemn several types that we have tried. Our work has indicated that in order to achieve any material improvement over the ordinary practice of zinc smelting, it is necessary to abandon certain features of the latter and contemplate continuous charging of the ore and reduction material and discharging the residuum without interfering with the process of distillation. These conditions introduce a multitude of perplexing difficulties that can be worked out only by tedious experimentation.

In a paper read before the Canadian Mining Institute, March 8, 1912, Mr. Ingalls advances the rather pessimistic conclusion that electrothermic zinc smelting has no future, except under special conditions of extraordinarily cheap power, etc., until the crucial point has been accomplished of reducing and distilling the zinc and condensing commercial proportions of the latter as spelter.

On the other hand, Dr. Joseph W. Richards,[2] in a description of the Johnson electric zinc furnace, says that in usual retort practice 20 to 30 per cent of the zinc distilled is caught as zinc dust and must be recharged, and that Johnson obtained better results than these in the condenser attached to his 25-kilowatt experimental electric furnace. However, Ingalls [3] says that in good retort practice the proportion of zinc dust formed varies from 5 to 10 per cent of the total zinc distilled over.

Weeks [4] has described the results of several trial runs of zinc dross in his arc-heat radiating electric furnace, in which 1,600 pounds of metallic zinc was recovered without the production of blue powder or zinc dust. In one run of 36 hours, 35 pounds of spelter were tapped per hour, the tap being limited by the size of the condenser, the furnace having the greater capacity. The refined zinc produced had an assay of:

*Analyses of zinc dross and spelter refined therefrom in Weeks's electric furnace.*

| Zinc dross charged. | Per cent. | Refined spelter. | Per cent. |
|---|---|---|---|
| Iron | 6.50 | Iron | 0.024 |
| Lead | 2.00 | Lead | .666 |
| Undetermined | 6.00 | Cadmium | .105 |
| Zinc | 85.50 | Zinc (by difference) | 99.205 |
| | 100.00 | | 100.00 |

[1] Canadian Min. Jour., Oct. 15, 1911, pp. 668–669.
[2] Trans. Am. Electrochem. Soc., vol. 19, 1911, pp. 311–316.
[3] Ingalls, W. R., Metallurgy of zinc and cadmium, New York, 1906, p. 205.
[4] Weeks, C. A., Melting nonferrous metals in an electric furnace: Met. and Chem. Eng., vol. 9, July, 1911, pp. 363–365.

The cost of treating zinc dross in this furnace is said to compare "more than favorably" with the cost of refining in retorts.

### RETORT SMELTING.

F. L. Clerc[1] has proposed to smelt roasted zinc ores in large retorts 17 feet long by 20 inches wide, constructed of fire brick, having the bottom covered with a layer of molten copper, upon the surface of which reduction of the ore and distillation of the zinc takes place. Manifestly such a retort would work to best advantage only upon material in as pure state as possible, and the inventor specifies 75 per cent zinc content as about the minimum. To make the process of general use and of particular applicability to the lower grade carbonate ores of Leadville, which are not marketable in their present tenor and not susceptible of concentration by the usual means, Clerc has further proposed[2] that these zinc ores be subjected to igneous concentration in furnaces such as those of Wetherill, Lewis & Bartlett, the resulting zinc oxide to be reduced in the large retorts as described above and the residues from the furnaces, if valuable, to be smelted in lead or copper furnaces. In this connection it may be pointed out that the Bertha Mineral Co., a subsidiary of the New Jersey Zinc Co., has for several years been using such a concentration process to utilize tailings from the mill at Austinville, Va., and also low-grade zinc ores.

> The zinc oxide plant, consisting of 12 furnaces, has only recently been added, mainly for the purpose of utilizing the low-grade ore and tailings. After thorough testing the plant has proved entirely satisfactory. The grade of ore, including tailings, used for making the oxide, will run from 15 to 20 per cent metallic zinc. * * * At present the zinc oxide goes to the furnaces at Pulaski, where it is used for making spelter.[3]

In a still later paper Clerc[4] describes in greater detail the construction of the copper-bottomed retorts, their aggregation in furnaces of eight retorts with a common heating chamber, the construction of the condensers, and a device for preheating and feeding the charge consisting of briquets of ore and reducing material. He also points out that practically all of whatever of the precious metals have been volatilized in the igneous concentration and have passed over into the zinc oxide, will be collected in the molten copper of the zinc furnace.

### ZINC SMELTERS.

The following table gives the zinc-smelting capacity of the United States as determined by a recent canvass. Those plants which have an "A" in the column headed "Acid plant" operate sulphuric-acid plants, either at the smelter or elsewhere as indicated in the footnotes.

---

[1] Proc. Colorado Sci. Soc., vol. 10, 1911, pp. 85–98; also Met. and Chem. Eng., Aug. 1912.
[2] Eng. and Min. Jour., Jan. 13, 1912, pp. 127–131.
[3] Watson, T. L., Lead and zinc deposits o Virginia: Bull. Virginia Geol. Survey No. 1, 1905, pp. 139–140.
[4] Met. and Chem. Eng., Aug. 1912, pp. 463–467.

*List of active zinc smelters in the United States, showing capacity in 1911, by companies and States.*

| Company and State. | Location. | Acid plant. | Retorts at close of 1911. | Additional retorts contemplated in 1912. |
|---|---|---|---|---|
| COLORADO. | | | | |
| United States Zinc Co | Pueblo | | 1,680 | |
| ILLINOIS. | | | | |
| American Zinc Co. of Illinois | Hillsboro | A | | 4,000 |
| Collinsville Zinc Co | Collinsville | | 1,528 | |
| Hegeler Bros | Danville | A | 1,800 | 1,800 |
| Illinois Zinc Co | Peru | A | 4,640 | |
| Matthiesson & Hegeler Zinc Co | La Salle | A | 4,380 | 876 |
| Mineral Point Zinc Co | Depue | A | 4,520 | |
| R. H. Lanyon Zinc & Acid Co | Hillsboro | A | | 1,600 |
| Sandoval Zinc Co | Sandoval | | 996 | |
| United Zinc & Chemical Co | Springfield | A[a] | 3,680 | |
| Total | | | 21,544 | 8,276 |
| KANSAS. | | | | |
| American Zinc, Lead & Smelting Co | Caney | | 3,648 | |
| Do | Dearing | | 3,840 | |
| Beer, Sondheimer & Co | Altoona | | 3,300 | |
| Chanute Zinc Co | Chanute | | 1,280 | |
| Edgar Zinc Co | Cherryvale | | 4,800 | |
| Granby Mining & Smelting Co | Neodesha | | 3,840 | |
| Pittsburg Zinc Co | Pittsburg | | 910 | |
| Prime Western Spelter Co | Gas | | 5,384 | |
| L. Vogelstein & Co | do | | 2,520 | |
| Do | La Harpe | | 1,856 | |
| Total | | | 31,378 | |
| MISSOURI. | | | | |
| Edgar Zinc Co | St. Louis | | 2,016 | |
| Nevada Zinc Co | Nevada | | 672 | |
| Total | | | 2,688 | |
| OKLAHOMA. | | | | |
| Bartlesville Zinc Co | Bartlesville | | 5,184 | |
| Do | Collinsville | | 1,280 | 1,920 |
| Lanyon-Starr Smelting Co | Bartlesville | | 3,456 | |
| National Zinc Co | do | | 2,380 | |
| Tulsa Fuel & Manufacturing Co | Collinsville | | 3,320 | 1,920 |
| Total | | | 15,620 | 3,840 |
| PENNSYLVANIA. | | | | |
| New Jersey Zinc Co. (of Pennsylvania) | Palmerton | | 2,892 | 2,880 |
| WEST VIRGINIA. | | | | |
| Grasselli Chemical Co | Clarksburg | A[b] | 5,760 | |
| Do | Meadowbrook | A[b] | 3,456 | |
| Total | | | 9,216 | |
| Total for all States | | | 85,018 | 14,996 |

[a] The United Zinc & Chemical Co. has zinc-roasting furnaces at Argentine, Kans., where the sulphur gases are utilized in an acid plant, the roasted concentrates being shipped to the smelter at Springfield, Ill.

[b] The Grasselli Chemical Co. operates acid plants in connection with its zinc-roasting furnaces at Grasselli, Ind., Cleveland, Ohio, and Newcastle, Pa., the roasted zinc concentrates being shipped to the smelters at Clarksburg and Meadowbrook, W. Va.

From the foregoing 85,018 retorts listed as in existence at the close of 1911 there should be subtracted 15,508 retorts at plants either idle during the year, or just completed at the close of the year, or engaged in smelting secondary material, leaving 69,510 retorts as active during the latter part of the year. At an average of 4¼ tons

of spelter per annum for each retort, this would give 295,418 tons as the active smelting capacity at the close of the year. Considering the quantity of low-grade ore smelted and the output for the year, 286,526 tons, it may be seen that the smelting capacity must have been crowded during the latter part of the year.

### SMELTER CHANGES.

Three new smelters were completed during the year, the plant of the Grasselli Chemical Co., at Meadowbrook, W. Va., with 2,280 retorts; the plant of the Tulsa Fuel & Manufacturing Co., at Collinsville, Okla., a subsidiary of the Prime Western Spelter Co., with 3,320 retorts; and the plant of the Bartlesville Zinc Co., also at Collinsville, Okla., with 1,280 retorts. At the last two plants the designed retort capacity was not complete at the close of the year. The remaining retorts to complete these plants, as well as the additional retort capacity planned for other smelters during 1912, so far as decided upon at the beginning of the year, is indicated in the list of smelters. Additions to capacity at plants already in operation were 3,446 retorts, 1,600 being added in Illinois and 1,822 in Oklahoma. The old Cockerill smelter at Nevada, Mo., idle for several years, was put in order for operation by the Nevada Zinc Co., and started operation early in 1912. The Pittsburg Zinc Co., at Pittsburg, Kans., altered the roasting furnaces, substituting the Parkinson coal-fired furnace for the natural-gas furnaces previously used. According to published reports,[1] this has resulted in a considerable saving, the cost of roasting zinc ore with natural gas at 3 cents per 1,000 feet being $1.75 per ton of ore and the cost with the new process being $1 per ton. The remodeled plant started up again near the close of the year.

The smelters under construction at Hillsboro, Ill., by the R. H. Lanyon Zinc and Acid Co. and the American Zinc Co. of Illinois will be completed before the close of 1912 with the capacity as shown in the list. The Granby Mining & Smelting Co. is constructing a smelter, with 2,880 retorts and an acid plant, at East St. Louis, Ill. It is expected to be ready for operation late in 1913.

The Mineral Point Zinc Co. is building an addition to its smelter at Depue, Ill., which will more than double the capacity. The addition, early in 1913, of 4,560 retorts to the 4,520 retorts already in operation will give a total of 9,080 retorts in one plant, much the largest zinc smelter in the United States. The completion of this addition, and of the additions under construction at other plants, together with the new plant at Hillsboro and the new Granby plant at East St. Louis, will give Illinois a total of 37,260 retorts, as against 31,378 retorts now active in Kansas.

Among foreign zinc smelters, the plant of the Broken Hill Proprietary Co., at Port Pirie, South Australia, was completed in 1911, with 1,440 retorts, and as a result the spelter production of Australia increased from 560 short tons in 1910 to 1,904 short tons in 1911. The year book of the Metallgesellschaft is authority for the statement that a Belgian company has been recently formed under the title of Rothem Spelter Works, to establish a plant at Rothem, Belgium,

[1] Dunn, J. A., Fuel economy in zinc metallurgy, power production, and mining: Met. and Chem. Eng., vol. 10, August, 1912, pp. 498–499.

which will join the Zinc Convention. A zinc smelter was operated in a small way in 1911 at Osaka, Japan, but the completion of the plant in 1912 will give it a capacity of 4,000 tons per year.[1]

## TRADE CONDITIONS.

### WORLD'S PRODUCTION.

The world's production of spelter in 1911 was again the largest in history, exceeding that of the record output of 1910 by 85,549 tons, or 9.6 per cent. The greatest increase was contributed by Germany, which exceeded its production of 1910 by 24,962 tons, or 9.9 per cent. Belgium made a gain almost equal in quantity and larger in proportion to its output than Germany, the increase being 24,817 tons, or 13 per cent. The United States was third with a gain of 17,342 tons, or 6.4 per cent. Good gains were also made by Austria, Italy, France, Spain, and Australia, and smaller gains by other countries, no country failing to show some increase. The output of the United States was 29.3 per cent of the total production of the world. The next largest producers were Germany, with 28.2 per cent of the world's production to its credit, and Belgium with 22 per cent.

The following totals, apportioned according to the country where smelted and not according to the source of the ore, are taken from the annual statistical publication for 1911 of the Metallgesellschaft, the Metallurgische Gesellschaft, A.-G., and the Berg- und Metallbank Aktiengesellschaft, of Frankfurt-am-Main, Germany, except that the figures for the United States are those of the United States Geological Survey:

*The world's production of spelter, 1905–1911, by countries, in short tons.*

| Country. | 1905 | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|---|---|
| Australia | ..... | 1,131 | 1,098 | 1,198 | ..... | 560 | 1,904 |
| Austria and Italy | 10,315 | 11,883 | 12,522 | 14,063 | 13,931 | 14,666 | 18,602 |
| Belgium | 160,496 | 168,067 | 170,307 | 181,851 | 184,194 | 190,233 | 215,050 |
| France and Spain | 55,524 | 59,293 | 61,438 | 61,512 | 61,859 | 65,191 | 70,791 |
| Germany | 217,356 | 225,997 | 230,058 | 239,062 | 242,594 | 251,046 | 276,008 |
| Great Britain | 56,140 | 57,971 | 61,286 | 60,029 | 65,422 | 69,531 | 73,803 |
| Holland | 15,176 | 16,150 | 16,526 | 19,017 | 21,548 | 23,121 | 25,059 |
| Poland | 8,422 | 10,595 | 10,735 | 9,740 | 8,758 | 9,514 | 10,952 |
| United States | 203,849 | 224,770 | 249,860 | 210,424 | 255,760 | 269,184 | 286,526 |
| Total | 727,278 | 775,857 | 813,830 | 796,896 | 854,066 | 893,046 | 978,695 |
| United States percentage of world's production | 28.0 | 29.0 | 30.7 | 26.4 | 29.9 | 30.1 | 29.3 |

### PRODUCTION OF SECONDARY SPELTER IN EUROPE.

The following table of the production of secondary spelter in Europe is calculated to short tons from a table published by Rudolf Wolff, Kreuger & Co., of London. It includes the output of the larger regular producers only. The production of the United States is included for comparison.

[1] Eng. and Min. Jour., vol. 93, Jan. 6, 1912.

*Production of secondary spelter in Europe and United States, 1905–1911, in short tons.*

| Country. | 1905 | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|---|---|
| Austria-Hungary | 3,505 | 3,674 | 3,931 | 3,315 | 3,102 | 2,934 | 3,282 |
| Belgium | 4,044 | 4,473 | 3,620 | 4,295 | 3,564 | 3,406 | 3,288 |
| France | 14,304 | 14,898 | 15,130 | 20,309 | 20,467 | 20,691 | 24,345 |
| Germany | 9,689 | 11,040 | 11,316 | 13,273 | 14,943 | 15,133 | 16,022 |
| Great Britain | 7,913 | 7,644 | 7,168 | 8,714 | 8,454 | 7,605 | 9,296 |
| Holland | 2,268 | 2,800 | 2,957 | 2,923 | 2,184 | 2,610 | 2,722 |
| Russia | 1,680 | ..... | 1,680 | 1,680 | ..... | 224 | 168 |
| United States | ..... | ..... | 18,841 | 16,970 | 33,040 | 41,223 | 40,513 |
| Total | 43,403 | 44,529 | 64,643 | 71,479 | 85,754 | 93,826 | 99,636 |

## IMPORTS AND EXPORTS.

### WAREHOUSE TRANSACTIONS.

Zinc imported into the United States as metal or in ore may be entered for immediate consumption, in which case the duty is paid and the zinc goes direct to the consumer; or it may be entered for warehouse, bond being given for double the amount of the estimated duty. From warehouse the zinc may be withdrawn for consumption by payment of duty, or it may be smelted in bond, finally being either withdrawn for consumption or exported from warehouse with cancellation of bond. The zinc entered for immediate consumption and that withdrawn from warehouse for consumption make up the table below of imports for consumption, which are expressed in the same terms in which they were imported. The zinc imported for consumption may be actually used in the country or it may be manufactured and exported, in which case the manufacturer is entitled to the benefit of a drawback of 99 per cent of the duties paid. In the table below showing foreign zinc exported in manufactures with benefit of drawback the zinc is shown in the form in which it was originally imported. On account of diversity of form it is not feasible to show the articles exported with benefit of drawback. The foreign zinc given in the table below as exported from warehouse is likewise shown in the form in which it was imported and entered for warehouse. A somewhat more detailed explanation of warehouse transactions is given in the chapter on lead in this volume. The following tables of imports and exports of zinc and of zinc remaining in warehouse are made up from the publications and records of the Bureau of Statistics.

The quantity of zinc remaining in warehouse at the close of the years previous to 1909 has been negligible, but since all zinc ore became dutiable on August 6, 1909, the quantity of bonded zinc has largely increased.

Practically all the zinc remaining in warehouse, as shown in the table below, is credited to the port of Kansas City, Mo., and is in possession of the bonded zinc smelters of Kansas and Oklahoma.

*Zinc remaining in warehouse, Dec. 31, 1909–1911.*

| Year. | Ore and calamine. | | | Blocks, pigs, and old. | |
|---|---|---|---|---|---|
| | Short tons. | Zinc content. | Value. | Quantity. | Value. |
| | | *Pounds.* | | *Pounds.* | |
| 1909 | 2,813 | 2,255,341 | $36,384 | 78,667 | $4,021 |
| 1910 | 2,603 | 2,572,122 | 61,730 | 61,146 | 3,406 |
| 1911 | 10,177 | 6,978,098 | 137,055 | 63,454 | 4,049 |

The figures for 1910 are exclusive of 2,627,939 pounds of zinc contained in 10,359 short tons of other ore entered at New York and valued at $131,397, and the figures for 1911 are exclusive of 8,911,376 pounds of zinc contained in 36,038 tons of other ore, valued at $178,228, all of which zinc was lost in smelting the ore, as explained later in the discussion of the general imports of zinc ore.

### IMPORTS.

*Zinc imported and entered for consumption in the United States, 1902–1911, in short tons.*

| Year. | Block or pigs. | | Sheets. | | Old. | | Value of manufactures. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | | |
| 1902 | 448 | $36,536 | 68 | $8,339 | 157 | $8,299 | $32,708 | $85,882 |
| 1903 | 202 | 19,161 | 129 | 8,537 | 163 | 11,772 | 10,376 | 49,846 |
| 1904 | 341 | 34,211 | 17 | 2,230 | 36 | 3,247 | 10,394 | 50,082 |
| 1905 | 428 | 46,295 | 14 | 1,953 | 86 | 5,110 | 8,253 | 61,611 |
| 1906 | 1,021 | 240,632 | 22 | 3,236 | 79 | 7,647 | 2,904 | 254,419 |
| 1907 | 1,709 | 220,474 | 52 | 7,158 | 122 | 8,582 | 8,516 | 244,730 |
| 1908 | 776 | 78,160 | 37 | 4,570 | 37 | 2,014 | 5,645 | 90,389 |
| 1909 | 9,419 | 805,087 | 117 | 13,510 | 238 | 9,999 | 6,488 | 835,084 |
| 1910 | 989 | 95,410 | 255 | 36,741 | 73 | 5,685 | 1,526 | 139,362 |
| 1911 | 323 | 38,322 | 291 | 55,211 | 104 | 8,609 | 7,981 | 110,123 |

The foregoing figures are exclusive of the quantity and value of zinc dust imported for consumption. Prior to August 6, 1909, zinc dust was entered free of duty under "articles in a crude state used in dyeing and tanning," and as such was not separately enumerated by the Bureau of Statistics. Since the date mentioned, zinc dust bears a duty of 1⅛ cents per pound, and is separately enumerated under "imports for consumption," though included with spelter in the Monthly Summary of general imports. The imports for consumption of zinc dust for the period August 6 to December 31, 1909, were 431,660 pounds, valued at $19,464. This quantity and value is included in the total for the year as given in the table below. The quantity of zinc dust imported for consumption in 1910 and its value are also as given in the table. The only statistics available for the time before August 6, 1909, are those of foreign countries relating to their exports of zinc dust to the United States. Among these countries are Germany, Belgium, France, Holland, and Denmark, but only in the reports of the first-mentioned country are the exports of zinc dust segregated from other exports. Germany furnishes much the larger part, amounting to about 95 per cent of the total imports of zinc dust; for this reason the zinc dust exports from Germany to the United States from March 1, 1906, to August 5, 1909, inclusive, as compiled from the annual Statistik des Deutschen Reichs, Auswärtiger Händel, and shown in the following table, give a fair idea of the total consumption of zinc dust in the United States for that period.

*Imports of zinc dust, 1906–1911, in pounds.*

| Year. | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1906 [a] | 1,818,576 | $108,052 | 1909 | 2,520,740 | $130,662 |
| 1907 | 1,893,090 | 106,386 | 1910 | 2,985,088 | 136,749 |
| 1908 | 2,625,238 | 136,136 | 1911 | 3,426,161 | 177,420 |

[a] March–December, 1906; for period preceding, zinc dust is not separately enumerated.

In view of the general interest in the importation of zinc ores, a table is given below, showing the entry of such ores from Mexico and Canada for 1904–1911 by calendar years. These general imports of zinc ores differ from "imports for consumption" by the difference in stock in bonded warehouse at the beginning and close of the year.

*Imports for consumption of zinc ore and calamine, 1909–1911.*

| Year. | Containing less than 10 per cent of zinc (duty, free). | | Containing from 10 to 20 per cent of zinc (duty, ¼ cent per pound). | | Containing from 20 to 25 per cent of zinc (duty, ½ cent per pound). | | Containing 25 per cent or more of zinc (duty, 1 cent per pound). | |
|---|---|---|---|---|---|---|---|---|
| | Zinc content. | Value. | Zinc content. | Value. | Zinc content. | Value. | Zinc content. | Value. |
| | *Pounds.* | | *Pounds.* | | *Pounds.* | | *Pounds.* | |
| 1909 [a] | ..... | ..... | 333,144 | $8,690 | 225,302 | $5,632 | 9,390,620 | $161,430 |
| 1910 | 31,899 | $698 | 174,697 | 4,053 | 2,355,748 | 25,126 | 39,921,939 | 713,684 |
| 1911 | 77,383 | 1,411 | 377,884 | 8,705 | 1,128,238 | 16,914 | 6,695,633 | 120,727 |

[a] For period July 1–Dec. 31 only.

The statistics of general imports as published by the Bureau of Statistics are based on "consular invoice" or "declaration," which is a close approximation only to actual weights and values. The true weights and values of all dutiable articles are determined when the duties are paid, and the correction is applied as "additions by liquidation" or "deductions by liquidation." On free articles this correction is not made. Prior to 1909 zinc ore was in large part undutiable, and in that part of 1909 prior to August 6 a portion of the imports of zinc ore was free. The correction by liquidation for the dutiable zinc ore imported during 1909–1911 is shown in the table. Inasmuch as this correction takes the form of "addition," it shows that the actual imports of zinc ore for preceding years exceed the figures in the table by an unknown quantity. Beginning with August 6, 1909, the corrections by liquidation apply to the total imports, thereby giving exact figures of such imports.

*General imports of zinc ore from Canada and Mexico, 1904–1911, in short tons.*

| | Canada. | | Mexico. | | Total. | |
|---|---|---|---|---|---|---|
| | Ore. | Zinc content. | Ore. | Zinc content. | Ore. | Zinc content. |
| 1904 | ..... | ..... | 2,264 | ..... | 2,264 | ..... |
| 1905 | 4,063 | ..... | 18,074 | ..... | 22,137 | ..... |
| 1906 | 423 | ..... | 59,991 | ..... | 55,414 | ..... |
| 1907 | 1,112 | ..... | 102,005 | ..... | 103,117 | ..... |
| 1908 | 7,406 | ..... | 46,351 | ..... | 53,757 | ..... |
| 1909 | 10,024 | ..... | 104,826<br>a+ 1,419 | ..... | 116,269 | ..... |
| 1910 | 4,749 | 1,922 | 67,818<br>a+14,839 | 23,517<br>a+16,917 | b 87,406 | b 42,356 |
| 1911 | 2,359 | 947 | 36,847<br>a+39,135 | 14,986<br>a+15,707 | c 78,341 | c 31,640 |
| Grand total, 1904–1911 | ..... | ..... | ..... | ..... | ..... | ..... |

[a] Plus (+) indicates "addition by liquidation."

[b] Exclusive of 822 short tons of zinc ore, valued at $698 and containing 31,889 pounds of zinc which entered free of duty as containing less than 10 per cent of zinc.

[c] Exclusive of 1,092 short tons of zinc ore valued at $1,411 and containing 77,383 pounds of zinc which entered free of duty as containing less than 10 per cent of zinc.

The foregoing figures of imports of zinc ore in 1910 are exclusive of 10,431 short tons of lead ore which carried 2,645,111 pounds of zinc as an accessory constituent, an average of less than 13 per cent, which was lost in smelting the lead and hence for the purpose of this report not to be classed with zinc ore imports so long as the present metallurgical treatment of that ore obtains. This ore was shipped from South American ports and largely entered through the port of New York. It is shown in the Monthly Summary of the Bureau of Statistics under the heading of "Merchandise remaining in warehouse," mostly at New York. Later on in this chapter under the heading "Customs duties on zinc" mention is made of recent customs litigation in regard to ores bearing more than one dutiable metal.

*Zinc oxide imported and entered for consumption, 1901–1911, in short tons.*

| Year. | Dry. | In oil. | Year. | Dry. | In oil. |
|---|---|---|---|---|---|
| 1901 | 1,800 | 64 | 1907 | 2,656 | 181 |
| 1902 | 1,636 | 82 | 1908 | 2,318 | 105 |
| 1903 | 1,744 | 83 | 1909 | 3,060 | 268 |
| 1904 | 1,293 | 112 | 1910 | 3,069 | 168 |
| 1905 | 1,718 | 171 | 1911 | 2,506 | 274 |
| 1906 | 2,096 | 146 | | | |

*Imports of old brass fit only for remanufacture, 1903–1911, in pounds.*

[Average composition about one-third zinc and two-thirds copper.]

| Year. | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1903 | 1,216,683 | $154,260 | 1909 | 4,672,575 | $579,454 |
| 1904 | 2,659,054 | 310,311 | 1910 | 6,144,564 | 785,684 |
| 1905 | 9,676,798 | 1,169,320 | 1911 | 3,605,106 | 445,116 |
| 1906 | 12,938,205 | 1,891,126 | | | |
| 1907 | 7,957,015 | 1,344,753 | Total | 51,584,155 | 7,035,359 |
| 1908 | 2,714,155 | 355,335 | | | |

## EXPORTS.

### DOMESTIC EXPORTS.

The practice of the Bureau of Statistics is to class all exports of zinc articles made in this country as domestic exports, whether the zinc be of domestic or foreign origin. Hence the following table of domestic exports is duplicated in part in a later table of foreign zinc in manufactures exported with benefit of drawback. The exports of zinc ore in the table below are of domestic origin and in recent years have all been from one mine in New Jersey. The exports of plates, sheets, pigs, or bars are likewise probably wholly domestic, since as shown later all the zinc in manufactures going out under drawback came in as blocks, pigs, and sheets, and the only manufacturing process which would put any of these into the class of exports referred to is rolling into sheets. But the zinc rolling mills in this country do not use foreign spelter, hence the conclusion that the plates, sheets, pigs, and bars of the table are of domestic origin. The zinc dross exports are no doubt in part of foreign origin, but in what proportion can not be determined. However, they are not duplicated in the drawback table. The exports of manufactures, of which the value is given, include

the value of the whole of the manufactures exported with benefit of drawback, as well as whatever manufactures of domestic zinc may be exported.

*Exports of domestic zinc ore and of domestic manufactures of zinc, 1902–1911, in short tons.*

| Year. | Zinc ore. | | Plates, sheets, pigs, or bars. | | Zinc dross.[a] | | Value of manufactures. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | | |
| 1902 | 55,733 | $1,449,104 | 3,237 | $300,557 | ..... | ..... | $114,197 | $1,863,858 |
| 1903 | 39,411 | 987,000 | 1,521 | 163,379 | ..... | ..... | 71,354 | 1,221,733 |
| 1904 | 35,911 | 905,782 | 10,147 | 1,094,490 | ..... | ..... | 117,957 | 2,118,229 |
| 1905 | 30,946 | 848,451 | 5,516 | 682,254 | ..... | ..... | 159,995 | 1,690,700 |
| 1906 | 27,720 | 733,300 | 4,670 | 583,526 | 15,887 | $1,103,706 | 204,269 | 2,624,801 |
| 1907 | [b] 20,352 | 579,490 | 563 | 75,194 | 9,593 | 560,944 | 186,203 | 1,401,831 |
| 1908 | [b] 26,108 | 877,745 | 2,640 | 250,254 | 8,405 | 467,403 | 88,485 | 1,683,887 |
| 1909 | [b] 12,455 | 412,300 | 2,566 | 263,010 | 7,069 | 477,112 | 69,751 | 1,222,173 |
| 1910 | [b] 19,711 | 649,425 | 3,990 | 426,560 | 4,729 | 380,950 | 101,336 | 1,558,271 |
| 1911 | [b] 18,281 | 642,884 | 6,872 | 810,099 | 4,246 | 348,176 | 134,518 | 1,935,677 |

[a] Not separately enumerated prior to 1906.
[b] The exports consisted wholly of high-grade willemite ore from New Jersey.

*Exports of zinc oxide, 1902–1911, in short tons.*

| Year. | Quantity. | Value. | Year. | Quantity. | Value |
|---|---|---|---|---|---|
| 1902 | 5,358 | $433,722 | 1907 | 13,257 | $1,069,924 |
| 1903 | 7,215 | 578,215 | 1908 | 12,008 | 845,070 |
| 1904 | 8,157 | 628,494 | 1909 | 14,846 | 1,026,377 |
| 1905 | 11,280 | 810,203 | 1910 | 13,167 | 943,968 |
| 1906 | 15,578 | 1,149,297 | 1911 | 14,618 | 1,051,311 |

## FOREIGN EXPORTS.

By foreign zinc exports is meant the exports of zinc of foreign origin which has been smelted or manufactured in this country and then shipped abroad. The following table, made up from the records of the Bureau of Statistics, shows the total zinc exported from warehouse during the last six years, the exports previous to that period being of insignificant proportions, and also the foreign zinc exported in manufactures with benefit of drawback for the same period. These two items—foreign zinc exported from warehouse and foreign zinc in manufactures exported with benefit of drawback—make up the total foreign zinc going out of the country. Zinc in warehouse and deductions by liquidation being disregarded, the difference between the sum of these two exports of zinc and the total imports of zinc constitutes the foreign zinc consumed in this country. It must be clearly understood in regard to this table that the zinc was not exported as zinc content of ore and blocks, pigs, etc., but as zinc smelted or manufactured from them. The reason for this is that the zinc in bonded customs warehouse is carried on the records until the bond is canceled in the same form in which the zinc was entered for warehouse. The zinc content of the foreign ore is, of course, exported as spelter. Under present customs regulations 90 per cent of the total zinc content must be exported to secure cancellation of bond. The quantities of zinc exported from warehouse are exact, but the quantities as

given of zinc exported in manufactures under drawback are subject to wastage in manufacturing.

There is no record kept of the form in which the zinc is actually exported, except in case of a portion of the articles manufactured from foreign zinc and exported with benefit of drawback. Unless the zinc be the constituent of chief value, the actual amount of zinc is not recorded. But each shipment on which drawback is claimed is accompanied by a manifest of the imported zinc which was used in making the articles as well as the duty paid thereon. From these manifests is made up the statement of the total quantity of foreign zinc which went into manufactures exported with benefit of drawback, and for this reason the zinc is given in the form in which it was imported.

*Exports of foreign zinc, 1905–1911, in pounds.*

| Year | Exported from warehouse. | | | | | Exported in manufactures with benefit of drawback. |
|---|---|---|---|---|---|---|
| | Ore and calamine, zinc content.[a] | | Blocks, pigs, and old. | | All other manufactures. | Blocks, pigs, sheets, and all other manufactures. |
| | Quantity. | alue. | Quantity. | Value. | Value. | Quantity. |
| 1905 | ..... | ..... | 38,753 | $816 | $1,015 | ..... |
| 1906 | ..... | ..... | 2,779 | 252 | 1,962 | 4,469 |
| 1907 | ..... | ..... | 17,458 | 1,023 | 1,504 | 3,110,239 |
| 1908 | ..... | ..... | 16,748 | 964 | 4,635 | 2,468,365 |
| 1909 | [a] 655,102 | $6,429 | 12,569 | 752 | 521 | 610 |
| 1910 | 9,420,984 | 182,345 | 94,672 | 4,884 | 1,121 | 8,972,427 |
| 1911 | 21,636,946 | 476,233 | 915,823 | 21,141 | 2,701 | 6,157,328 |

[a] After Aug. 6, 1909.

## CUSTOMS DUTIES ON ZINC.

The tariff act of 1909, effective August 6, has the following sections relating to zinc ore, zinc, and to compounds containing zinc:

PAR. 55. Zinc, oxide of, and white pigment containing zinc, but not containing lead, dry, one cent per pound; ground in oil, one and three-fourths cents per pound; sulfid of zinc, white, or white sulphide of zinc, one and one-fourth cents per pound; chloride of zinc and sulphate of zinc, one cent per pound.

PAR. 193. Zinc-bearing ore of all kinds, including calamine, containing less than ten per centum of zinc, shall be admitted free of duty; containing ten per centum or more of zinc, and less than twenty per centum, one-fourth of one cent per pound on the zinc contained therein; containing twenty per centum or more of zinc and less than twenty-five per centum, one-half of one cent per pound on the zinc contained therein; containing twenty-five per centum of zinc, or more, one cent per pound on the zinc contained therein: *Provided*, That on all importations of zinc-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of Government officers, who shall be stationed at such establishments, and who shall submit the samples thus obtained to a Government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample, and report the result to the

proper customs officers, and the import entries shall be liquidated thereon, except in case of ores that shall be removed to a bonded warehouse to be refined for exportation as provided by law. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

PAR. 194. Zinc in blocks or pigs and zinc dust, one and three-eighths cents per pound; in sheets, one and five-eighths cents per pound; in sheets coated or plated with nickel or other metal or solutions, one and three-fourths cents per pound: old and worn-out, fit only to be remanufactured, one cent per pound.

Section 24 of the tariff act of 1909 provides for the establishment of bonded smelting warehouses for smelting or refining in bond of ores and crude metals, but makes provision for the withdrawal from same of lead alone. Upon application of the United States Zinc Co. the Treasury Department made the following ruling (T. D. 30015):

TREASURY DEPARTMENT, *September 29, 1909.*

SIR: In a letter dated the 24th instant the department confirmed its telegram of the same date approving the application of the United States Zinc Co. to bond as a warehouse of class 7 its works at Pueblo, Colo., for the smelting and refining of imported ores.

As it appears from correspondence with this company that the works have been bonded for the smelting of zinc ores and the exportation of the refined metal, I have to advise you that there is no provision in the tariff act of August 5, 1909, for the remission of duty upon zinc withdrawn for exportation from a bonded smelter, as section 24 of this act provides only for the exportation of lead from bonded smelters. Section 29 of the tariff act July 24, 1897, provides for the bonding of the works of manufacturers engaged in smelting or refining metals, or both smelting and refining, and for the cancellation of the bonds for the payment of the duty upon the exportation of 90 per cent of the metals smelted or refined.

In the opinion of the department there is nothing inconsistent in the provisions of the two acts in so far as they relate to metals other than lead, and it therefore construes section 29 of the act of July 24, 1897, as remaining in force to this extent, and you are therefore authorized to permit the zinc to be withdrawn from the United States Zinc Co.'s works, located at Pueblo, as provided therein—that is, the bond given for the exportation of the refined zinc should be canceled upon the exportation of 90 per cent of the zinc as shown by the assay to be in the imported ore and so charged against the bond.

Respectfully, CHARLES D. NORTON,
*Acting Secretary.*

SURVEYOR OF CUSTOMS, *Denver, Colo.*

The following zinc smelters have been established as bonded smelting warehouses for the treatment of foreign zinc ore and as such are entitled to the cancellation of the bond on importations of such ore upon the exportation of 90 per cent of the zinc content and all of the recovered lead content of such ores:

*List of bonded zinc smelters, 1911.*

Lanyon Zinc Co., Iola and La Harpe, Kans.
Prime Western Spelter Co., Gas and Iola, Kans.
A. B. Cockerill, Nevada and Rich Hill, Mo.
Cockerill Zinc Co., Altoona and Pittsburg, Kans.
Wm. Lanyon, Iola and Pittsburg, Kans.
La Harpe Smelting Co., La Harpe, Kans.
Bartlesville Zinc Co., Bartlesville, Okla.
National Zinc Co., Bartlesville, Okla.
Altoona Zinc Works, Altoona, Kans.
American Metal Co. (lead), La Harpe, Kans.
United States Zinc Co., Pueblo, Colo.

The Consolidated Kansas City Smelting & Refining Co. protested against the assessment of duty by the collector of customs at the port of El Paso upon both the lead and the zinc contents of ore, the importers claiming that either metal was lost in the attempt

to recover the other. The Board of Appraisers, June 27, 1910, rendered a decision (T. D. 30727) affirming the act of the collector. The importers appealed to the United States Court of Customs Appeals, the decision of which affirmed that of the Board of Appraisers.

## CONSUMPTION.

In the following tables, showing the consumption of spelter in the United States and in the world for the period 1898–1911, the figures of foreign consumption are computed from statistics published by the Metallgesellschaft for 1911. In those statistics consumption is calculated on the basis of production, plus excess of imports over exports or minus excess of exports over imports, and altogether disregards smelter stocks. For the sake of comparison the consumption of the United States is calculated by both methods. Although in the long run the stocks carried over from one year are consumed in the next, and thus are equalized, it can not be gainsaid that for the individual year to take stocks into account gives greater accuracy. To obtain perfectly accurate figures of consumption, it would be necessary to consider the stocks in the hands of consumers and dealers and to take into account the secondary spelter consumed.

*Consumption of primary spelter in the United States, 1907–1911, in short tons.*

| | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|
| Supply: | | | | | |
| Stock Jan. 1— | | | | | |
| In bonded warehouses | ..... | 2 | 9 | 39 | 31 |
| At smelters | 3,824 | 26,364 | 19,613 | 11,167 | 23,201 |
| Production | 249,860 | 210,424 | 255,760 | 269,184 | 286,526 |
| Imports | 1,778 | 881 | 9,454 | 1,960 | 609 |
| Total available | 255,462 | 237,671 | 284,836 | 282,350 | 310,367 |
| Withdrawn: | | | | | |
| Exports, foreign, from warehouse | 9 | 8 | 334 | 4,758 | 11,276 |
| Exports, foreign, under drawback | 1,555 | 1,234 | ..... | 4,486 | 3,079 |
| Exports, domestic | 563 | 2,640 | 2,566 | 3,990 | 6,872 |
| Stock, Dec. 31— | | | | | |
| In bonded warehouses | 2 | 9 | 39 | 31 | 32 |
| At smelters | 26,364 | 19,613 | 11,167 | 23,201 | 9,049 |
| Total withdrawn | 28,493 | 23,504 | 14,106 | 36,466 | 30,308 |
| Apparent consumption | 226,969 | 214,167 | 270,730 | 245,884 | 280,059 |

In considering the consumption of primary spelter there should be borne in mind the rapidly increasing quantity of secondary material, such as zinc skimmings, ashes, hard zinc, and scrap zinc, from which zinc is recovered in the form of spelter, alloy, pigment, chemical, etc., and so used again, thus affecting the consumption of primary spelter. The total quantity of secondary zinc recovered in 1911, so far as there is available record, was 74,747 tons as compared with 68,723 tons in 1910. For details of the recovery of secondary zinc in 1911 and previous years see under the heading "Secondary zinc" in this chapter.

*World's consumption of spelter, by countries, 1907–1911, in short tons.*

[Stocks disregarded except in the United States.]

| | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|
| Austria-Hungary | 34,171 | 35,925 | 36,155 | 37,258 | 47,950 |
| Belgium | 60,627 | 74,936 | 71,209 | 84,326 | 71,539 |
| France | 76,720 | 85,956 | 73,744 | 62,059 | 90,389 |
| Germany | 192,792 | 198,580 | 207,343 | 196,320 | 244,490 |
| Great Britain | 154,653 | 152,627 | 171,408 | 195,989 | 193,674 |
| Holland | 4,189 | 4,189 | 4,409 | 4,409 | 4,409 |
| Italy | 7,496 | 9,257 | 9,039 | 8,929 | 11,133 |
| Russia | 19,290 | 19,946 | 20,282 | 27,447 | 32,518 |
| Spain | 5,180 | 5,512 | 4,960 | 4,630 | 4,961 |
| Other countries | 13,228 | 11,020 | 9,921 | 13,668 | 17,857 |
| United States | 226,969 | 214,167 | 270,730 | 245,884 | 280,059 |
| Total | 795,315 | 812,115 | 879,200 | 880,919 | 998,979 |

*World's consumption of spelter, exclusive of secondary zinc, 1898–1911, in short tons.*

| Year. | Stocks considered. | Stocks disregarded. | | | |
|---|---|---|---|---|---|
| | United States. | United States. | Foreign countries. | Total world's consumption. | United States percentage. |
| 1898 | 108,199 | 106,185 | 422,070 | 528,255 | 20.10 |
| 1899 | 124,585 | 123,688 | 422,181 | 545,869 | 22.66 |
| 1900 | 99,399 | 102,414 | 420,858 | 523,272 | 19.57 |
| 1901 | 141,697 | 137,789 | 424,496 | 562,285 | 24.51 |
| 1902 | 152,682 | 154,138 | 465,391 | 619,529 | 24.88 |
| 1903 | 154,381 | 157,900 | 480,162 | 638,062 | 24.75 |
| 1904 | 180,911 | 176,804 | 520,506 | 697,400 | 25.36 |
| 1905 | 200,438 | 198,835 | 534,285 | 733,120 | 27.13 |
| 1906 | 220,781 | 221,142 | 556,882 | 778,024 | 28.42 |
| 1907 | 226,969 | 249,511 | 568,346 | 817,857 | 30.51 |
| 1908 | 214,167 | 207,423 | 597,948 | 805,371 | 25.75 |
| 1909 | 270,730 | 262,314 | 608,472 | 870,784 | 30.12 |
| 1910 | 245,884 | 257,910 | 635,035 | 892,945 | 28.88 |
| 1911 | 280,059 | 265,908 | 718,920 | 984,828 | 27.00 |

## USES OF SPELTER.

Statistics of the use of spelter are not collected by the United States Geological Survey. The following table is from figures published in the Engineering and Mining Journal, which, though confessedly not complete, will nevertheless give an idea of the relative importance of the different uses of spelter for the period included. Figures for 1911 are not available.

*Consumption of spelter in the United States, 1906–1910, by uses.*

| Use. | Percentage of total consumption. | | | | | |
|---|---|---|---|---|---|---|
| | 1905 | 1906 | 1907 | 1908 | 1909 | 1910 |
| Galvanizing | 50.00 | 55.00 | 62.7 | 62.2 | 62.7 | 60.0 |
| Brass making | 26.00 | 25.25 | 18.4 | 17.2 | 18.3 | 20.0 |
| Sheet zinc | 17.00 | 16.00 | 12.4 | 14.1 | 12.6 | 11.0 |
| Lead desilverization | 1.25 | 1.00 | 1.1 | 1.3 | 1.0 | ..... |
| Other purposes | 5.75 | 2.75 | 5.4 | 5.2 | 5.4 | 9.0 |
| Total | 100.00 | 100.00 | 100.0 | 100.0 | 100.0 | 100.0 |

### GRADES OF PRIMARY SPELTER.

The American Society for Testing Materials has adopted the following standard specifications for primary or virgin spelter:[1]

Under these specifications virgin spelter—that is, spelter made from ore or similar raw material by a process of reduction and distillation and not produced from reworked metal—is considered in four grades, as follows:

(*a*) High grade; (*b*) intermediate; (*c*) brass special; (*d*) prime western.

Marks: A brand shall be cast in each slab by which the maker and grade can be identified.

Lots: The maker shall use care to have each carload of as uniform a quality as possible.

#### COMPOSITION.

(*a*) High grade: The spelter must not contain over 0.07 per cent lead, 0.03 per cent iron, 0.05 per cent cadmium. It must be free from aluminum. The sum of the lead, iron, and cadmium must not exceed 0.1 per cent.

(*b*) Intermediate: The metal must not contain over 0.2 per cent lead, 0.03 per cent iron, 0.5 per cent cadmium. It must be free from aluminum. The sum of the lead, iron, and cadmium must not exceed 0.5 per cent.

(*c*) Brass special: The metal must not contain over 0.75 per cent lead, 0.04 per cent iron, 0.75 per cent cadmium. It must be free from aluminum. The sum of the lead, lead, iron, and cadmium must not exceed 1.2 per cent.

(*d*) Prime western: Must not contain over 1.5 per cent lead, 0.08 per cent iron.

Physical: The slabs must be reasonably free from surface corrosion or adhering foreign matter.

Sampling: Not less than 10 slabs shall be taken as a sample from each car; for smaller lots in the same proportion to the total number, but in no case less than 3 slabs. In case of dispute half of the sample is to be taken by the maker and half by the purchaser; the whole to be mixed.

The slabs selected as samples are to be sawed completely across and the sawdust used as a sample. In case no saw is available for this purpose the slabs should be drilled completely through and the drillings cut up into short lengths. The saw or drill used must be thoroughly cleaned. No lubricant shall be used in either sawing or drilling, and the sawdust or drilling must be carefully treated with a magnet to remove any particles of iron derived from the tools.

## PRICES AND VALUE.

### PRICES.

Spelter opened at St. Louis in January at 5.35 cents per pound, but broke to 5.275 cents by the end of the month, rising, however, to 5.55 cents per pound by the end of February, after which the price declined gradually until the latter part of May, when the minimum for the year was reached at 5.2 cents per pound, this being 0.1 cent less than the current London price. After this date the price rose by stages until the maximum for the year and the highest price since 1907 was reached, at 6.85 cents, on November 28. A sharp break immediately carried the price to 6.1 cents, and the year closed with spelter around 6.2 cents per pound. The average St. Louis price of prime western spelter was 5.7 cents per pound, as compared to 5.4 cents per pound in 1910. The average price of spelter at New York in 1911 was 5.8 cents, as compared with 5.5 cents in 1910. The average price of spelter at St. Louis is used by the United States Geological Survey in calculating the value of the domestic production of spelter.

In London, spelter, starting at £24 per long ton (5.2 cents per pound), reached the minimum of the year, £23 per long ton (5 cents

[1] Metal Industry, July, 1911, p. 301.

per pound), early in March. From that time on the price gradually rose, passing the average St. Louis price in May and early June, until the high point of the year and the highest price since early in 1907 was reached, at £27 17s. 6d. per long ton (6 cents per pound), in late August. For a space of seven weeks the average weekly London price was again higher than the average St. Louis price. A sharp decline followed, and the year closed with spelter worth about £26 18s. per long ton (5.8 cents per pound). The average London price of spelter for 1911 was £25 6s. per long ton (5.47 cents per pound).

In 1909 the price of zinc dust, duty free, in the first seven months, ranged from 5 to 5.5 cents per pound. After the new tariff became effective, August 6, 1909, the price varied from 6 to 6.5 cents per pound, the average for the year being 5.7 cents. The price of zinc dust in 1910 varied between 6.5 and 7 cents per pound, the average for the year being 6.7 cents.

The price of zinc dust through the first half of 1911 varied from 6.75 to 7 cents per pound. In August it rose to 7.5 cents, and during September and October ranged between 7.5 and 7.75 cents. In November the price dropped back to 7.5, closing the year at 7.375 cents. The price of zinc dust in Germany varied from 53 to 53.5 marks per 100 kilograms (5.7 to 5.8 cents per pound). Paul Speier reports an increased demand for zinc dust owing to its use in galvanizing iron wire.

The following table, giving highest and lowest prices of spelter in each month for the years 1902–1910 inclusive, is based on figures in the Iron Age prior to 1906. For 1906 and later the figures are based on the daily quotations in the Engineering and Mining Journal. Prior to 1909 the quotations are from New York City, but for 1909 and after St. Louis prices are taken.

*Monthly price range of prime western spelter, 1902–1911.*

[Cents per pound.]

| Year. | January. | | February. | | March. | | April. | |
|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| 1902 | 4.30 | 4.25 | 4.25 | 4.00 | 4.35 | 4.20 | 4.45 | 4.40 |
| 1903 | 4.90 | 4.55 | 5.05 | 4.97 | 5.75 | 5.05 | 5.75 | 5.50 |
| 1904 | 5.10 | 4.90 | 5.10 | 4.95 | 5.20 | 5.05 | 5.27 | 5.20 |
| 1905 | 6.20 | 6.10 | 6.15 | 6.10 | 6.15 | 5.87 | 6.00 | 5.75 |
| 1906 | 6.70 | 6.00 | 6.15 | 6.05 | 6.35 | 6.10 | 6.15 | 6.05 |
| 1907 | 6.80 | 6.70 | 6.90 | 6.70 | 6.90 | 6.75 | 6.80 | 6.55 |
| 1908 | 4.60 | 4.25 | 4.85 | 4.55 | 4.80 | 4.60 | 4.70 | 4.60 |
| 1909 | 5.20 | 5.075 | 5.075 | 4.525 | 4.625 | 4.55 | 4.95 | 4.60 |
| 1910 | 6.075 | 5.65 | 5.70 | 5.25 | 5.625 | 5.45 | 5.475 | 4.90 |
| 1911 | 5.425 | 5.275 | 5.55 | 5.25 | 5.525 | 5.30 | 5.325 | 5.25 |

*Monthly price range of prime western spelter, 1902–1911*—Continued.

| Year. | May. | | June. | | July. | | August. | |
|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| 1902 | 4.65 | 4.40 | 4.85 | 4.80 | 5.35 | 5.05 | 5.50 | 5.35 |
| 1903 | 5.80 | 5.75 | 6.25 | 5.75 | 6.25 | 5.87 | 6.00 | 5.80 |
| 1904 | 5.22 | 4.95 | 4.95 | 4.75 | 4.90 | 4.87 | 5.07 | 4.90 |
| 1905 | 5.70 | 5.40 | 5.35 | 5.25 | 5.60 | 5.25 | 5.80 | 5.60 |
| 1906 | 6.10 | 5.90 | 6.20 | 6.00 | 6.05 | 5.97 | 6.05 | 6.02 |
| 1907 | 6.60 | 6.35 | 6.45 | 6.35 | 6.35 | 5.85 | 5.90 | 5.50 |
| 1908 | 4.675 | 4.55 | 4.675 | 4.45 | 4.70 | 4.40 | 4.775 | 4.65 |
| 1909 | 5.125 | 4.875 | 5.325 | 5.10 | 5.325 | 5.175 | 5.675 | 5.325 |
| 1910 | 5.175 | 4.85 | 5.075 | 4.925 | 5.075 | 4.95 | 5.275 | 5.00 |
| 1911 | 5.25 | 5.20 | 5.65 | 5.20 | 5.70 | 5.525 | 6.05 | 5.675 |

| Year. | September. | | October. | | November. | | December. | |
|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| 1902 | 5.50 | 5.30 | 5.50 | 5.40 | 5.35 | 5.10 | 5.00 | 4.50 |
| 1903 | 6.10 | 6.00 | 6.12 | 6.00 | 6.00 | 5.25 | 5.25 | 4.65 |
| 1904 | 5.15 | 5.07 | 5.37 | 5.15 | 5.80 | 5.37 | 6.12 | 5.80 |
| 1905 | 5.95 | 5.75 | 6.15 | 6.00 | 6.25 | 6.10 | 6.60 | 6.40 |
| 1906 | 6.35 | 6.05 | 6.30 | 6.15 | 6.45 | 6.25 | 6.65 | 6.45 |
| 1907 | 5.50 | 5.05 | 5.55 | 5.25 | 5.25 | 4.50 | 4.55 | 4.10 |
| 1908 | 4.825 | 4.70 | 4.875 | 4.75 | 5.05 | 4.875 | 5.15 | 5.10 |
| 1909 | 5.80 | 5.55 | 6.275 | 5.775 | 6.275 | 6.175 | 6.225 | 6.00 |
| 1910 | 5.45 | 5.225 | 5.725 | 5.375 | 5.90 | 5.70 | 5.775 | 5.275 |
| 1911 | 5.95 | 5.80 | 6.25 | 5.825 | 6.85 | 6.25 | 6.80 | 6.10 |

## VALUE.

The value of the 1911 production of domestic primary spelter, 271,621 tons, based upon the average St. Louis price, was $30,964,794, as compared with 252,479 tons, valued at $27,267,732, St. Louis price in 1910, with 230,255 tons, valued at $24,864,300, St. Louis price, in 1909, and with 190,749 tons, valued at the average New York price at $17,930,406, in 1907.

## PRICE CURVES, 1906–1911.

The following curves show graphically for the years 1906–1911, inclusive, the relations of the weekly average St. Louis price of spelter, the weekly average London price of spelter, the weekly average price of 60 per cent zinc blende concentrates at Joplin, Mo., and the weekly production, or to be more exact, the weekly sales of concentrates in the Joplin region as a whole. The price of spelter has been taken from market reports, and the price of zinc blende and the figures of weekly production are those published in the Joplin daily papers. To eliminate the sharp weekly fluctuations and to obtain a curve more easily comparable with the price curves, the weekly sales have been averaged by months, the result being shown by the broken line.

The curve of London price of spelter shows the stabilizing effect of the Zinc Convention. The St. Louis price of spelter shows a minor dependence upon the English market, but a major independence of it. On the whole the price of zinc concentrates at Joplin shows a close correspondence to the price of spelter at St. Louis, though there are various minor discrepancies.

FIGURE 10.—Average weekly price of spelter at London and St. Louis, of 60 per cent zinc concentrates at Joplin, and weekly production (sales) of zinc concentrates in the Joplin region in 1906–7.

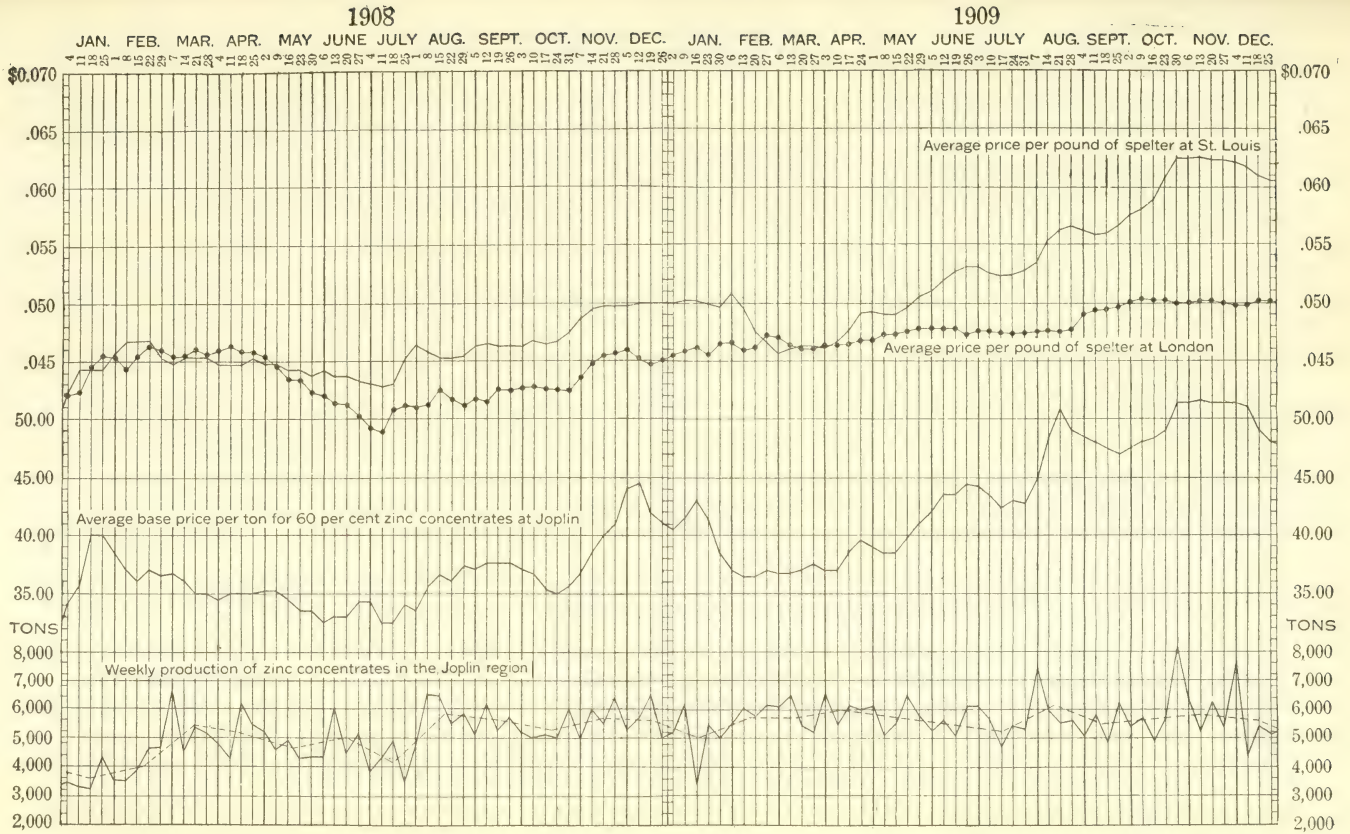



FIGURE 11.—Average weekly price of spelter at London and St. Louis, of 60 per cent zinc concentrates at Joplin, and weekly production (sales) of zinc concentrates in the Joplin region in 1908-9.

FIGURE 12.—Average weekly price of spelter at London and St. Louis, of 60 per cent zinc concentrates at Joplin, and weekly production (sales) of zinc concentrates in the Joplin region in 1910–11.

1910.

The London price of spelter remained fairly steady through the first quarter, but in April and May there was a considerable decline consequent upon increase in stocks and dissensions among the members of the Zinc Convention which made it seem probable that the agreement would not be renewed. The great drop in the price of spelter in the United States doubtless was also influential. However, conditions improved, the convention was renewed, and spelter slowly rose to the end of the year. At St. Louis spelter held steady through January; but at this time the large stocks in the hands of consumers and dealers, which stocks had accumulated in the preceding year in the expectation of tariff increases and business revival, began to make themselves felt, and in the next three months by a series of plunges, followed by partial recoveries, spelter dropped to 5 cents and went slightly below. A period of readjustment followed for three months with stationary price and curtailed production, after which spelter mounted rapidly until the close of November, but was then overtaken by a sharp reaction.

1911.

The price of spelter at London lost ground slightly during the first quarter, but there followed a steady rise which twice passed the current price of spelter in the United States. The high level was reached during the latter part of August and the price remained nearly stationary until the middle of October, after which there was a slight reaction to lower prices. The price in the United States, in the main, followed the London price except that at the middle of October, instead of falling, as did the foreign price, it continued by a sharp rise to the maximum early in December, after which there was a sharp decline.

### THE JOPLIN ORE SCALE.

Upon the organization of the Zinc Ore Producers' Association at Joplin, early in 1910, that body undertook to ascertain the best methods of marketing Joplin ore. The central selling agency and the sliding-scale contract were among the plans suggested. The ore scale was finally adopted, and by the close of the year about a fifth of the tonnage of the district had been contracted for under the uniform terms of the scale. That part of the contract governing prices is as follows:

Spelter quotation governing to be the average of the American Metal Market and Daily Iron Trade Reports, direct St. Louis wire, for the week preceding the delivery of such concentrates.

For concentrates, except sludges, carrying 60 units zinc, the sum of $37 per ton (2,000 pounds dry weight), when spelter is quoted at $5 per hundredweight, East St. Louis delivery.

Unit variation, $1 per ton for each unit above or below 60 per cent.

Price variation, 8.5 cents per ton up or down for each change of 1 cent per 100 pounds spelter.

Premium of $1 per ton for concentrates carrying one-half of 1 per cent lead or less.

Iron allowance: Two per cent, no penalty; above 2 per cent to and including 5 per cent, $1 per ton per unit penalty; above 5 per cent, 50 cents per unit.

On a declining market the ore contract naturally worked to the advantage of the producer, seeing that the selling price of ore was based on the average price of spelter for the preceding week. On a

rising market, however, the plan worked to the detriment of the producer. For a short time after the signing up of the scale the market declined and the contract price was satisfactory. During the latter part of the year, however, the continued rise in the price of spelter resulted in a weekly loss to those selling on contract and, furthermore, the lower price paid for the contract ore was thought to have a tendency to hold down offerings in the open market. The result was dissatisfaction with the ore scale, which became so great that on the expiration of the contracts at the close of the year very few were renewed.

## THE ZINC CONVENTION.

The Zinc Convention was formed early in 1909, to remain in force until the close of 1910. It comprised the Zinkhüttenverband m. b. H. and the Société Anonyme des Mines et Fonderies de la Vieille Montagne. The former association embraces 18 zinc smelting firms in Silesia, the Rhine district, Belgium, and Austria. One large firm, Georg von Giesche's Heirs, did not join the association, but acted in concert. The Société Anonyme includes 10 smelters, the majority located in Belgium. The more important English smelters joined the convention late in 1909. The purpose of the convention was to fix beforehand, within certain limits, the production of spelter by its members, and, if the market gave evidence that the consumption was not keeping pace with the production, further to curtail production. The output of the German group was limited to 255,700 metric tons in 1909 and to 264,200 metric tons in 1910, and the output of the Franco-Belgian group was not to exceed 174,500 metric tons in 1909 and 176,900 metric tons in 1910. The output of the English smelters under the terms of the agreement was to be approximately 55,000 metric tons annually. If the average price of ordinary brands of spelter remained below £19 per long ton (4.11 cents per pound) for six consecutive months, a pro rata reduction of the fixed output was to be made.

At the close of 1910 the Zinc Convention had, on the whole, worked so well that it was extended until April 30, 1914. Certain features which had aroused antagonism (notably the restriction clause) were modified in the new terms. Under the new agreement there will be no restriction of output so long as the total stocks of spelter, ascertained every quarter, do not exceed 50,000 metric tons and so long as the London price of spelter does not fall below £22 per long ton (4.8 cents per pound). Should this contingency arise, production is to be restricted pro rata on the basis of each smelter's output during the last quarter. The outstanding smelting firm, Georg von Giesche's Heirs, will sell its output through the association agencies and has agreed to the limitation clause, though it does not regularly become a member.

The steadying effect of the convention upon the European spelter market since its organization in 1909 is very graphically shown in the spelter price curves given on preceding pages.

## SUMMARY.

*Summary of spelter statistics for 1907–1911.*

| | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|
| Production of spelter by United States | 249,860 | 210,424 | 255,760 | 269,184 | 286,526 |
| Consumption of spelter by United States (stocks considered) | 226,969 | 214,167 | 270,730 | 245,884 | 280,059 |
| Production of spelter by world | 813,830 | 796,896 | 854,066 | 893,046 | 978,695 |
| Consumption of spelter by world (stocks considered in United States) | 795,315 | 812,115 | 879,200 | 880,919 | 998,979 |
| Excess of world production over consumption | 18,515 | ..... | ..... | 12,127 | ..... |
| Excess of world consumption over production | ..... | 15,219 | 25,134 | ..... | 20,284 |
| United States percentage of world production | 30.7 | 26.4 | 29.9 | 30.1 | 29.3 |
| United States percentage of world consumption (stocks considered in United States) | 28.5 | 26.4 | 30.8 | 27.9 | 28.0 |
| Rank of United States in spelter production | First. | Second. | First. | First. | First. |
| Rank of United States in spelter consumption | First. | First. | First. | First. | First. |

## SURVEY PUBLICATIONS ON LEAD AND ZINC.

The following list includes the more important publications on lead and zinc published by the United States Geological Survey. These publications, except those to which a price is affixed, can be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C.


ADAMS, G. I., Zinc and lead deposits of northern Arkansas: Bull. 213, 1903, pp. 187–196. 25c.

ADAMS, G. I., and others, Zinc and lead deposits of northern Arkansas: Prof. Paper 24, 1904, 118 pp.

BAIN, H. F., Lead and zinc deposits of Illinois: Bull. 225, 1904, pp. 202–207. 35c.

——— Lead and zinc resources of the United States: Bull. 260, 1905, pp. 251–273. 40c.

——— A Nevada zinc deposit: Bull. 285, 1906, pp. 166–169. 60c.

——— Zinc and lead deposits of northwestern Illinois: Bull. 246, 1905, 56 pp.

——— Zinc and lead deposits of the upper Mississippi Valley: Bull. 294, 1906, 155 pp.

——— Zinc and lead ores in 1905: Mineral Resources U. S. for 1905, 1906, pp. 379–392.

BAIN, H. F., VAN HISE, C. R., and ADAMS, G. I., Preliminary report on the lead and zinc deposits of the Ozark region: Twenty-second Ann. Rept., pt. 2, 1902, pp. 23–228. $2.25.

BANCROFT, HOWLAND, Reconnaissance of the ore deposits in northern Yuma County, Ariz.: Bull. 451, 1911, 130 pp.

——— Lead and zinc deposits of the Metaline mining district, northeastern Washington: Bull. 470, 1911, pp. 188–200.

BECKER, G. F., Geology of the Comstock lode and the Washoe district, with atlas: Mon. III, 1882, 422 pp. $11.

BOUTWELL, J. M., Economic geology of the Bingham mining district, Utah: Prof. Paper 38, 1905, pp. 73–385.

BOUTWELL, J. M., and WOOLSEY, L. H., Geology and ore deposits of the Park City district, Utah: Prof. Paper 77, 1912, 231 pp.

BUTLER, B. S., and DUNLOP, J. P., Silver, copper, lead, and zinc in the Central States in 1910 (mine production): Mineral Resources U. S. for 1910, pt. 1, 1911, pp. 611–674.[1]

CALKINS, F. C., and MACDONALD, D. F., A geologic reconnaissance in northern Idaho and northwestern Montana: Bull. 384, 1909, 112 pp.

CLERC, F. L., The mining and metallurgy of lead and zinc in the United States: Mineral Resources U. S. for 1882, 1883, pp. 358–386. 50c.

CROSS, WHITMAN, HOWE, ERNEST, and RANSOME, F. L., Silverton folio (No. 120), Geol. Atlas U. S., 1905. 25c.

CROSS, WHITMAN, SPENCER, A. C., and RANSOME, F. L., Rico folio (No. 130), Geol. Atlas U. S., 1905. 25c.

CROSS, WHITMAN, and HOLE, A. D., Engineer Mountain folio (No. 171), Geol. Atlas U. S., 1910. 25c.

CURTIS, J. S., Silver-lead deposits of Eureka, Nev.: Mon. VII, 1884, 200 pp. $1.20.

ELLIS, E. E., Zinc and lead mines near Dodgeville, Wis.: Bull. 260, 1905, pp. 311–315. 40c.

EMMONS, S. F., Geology and mining industry of Leadville, Colo., with atlas: Mon. XII, 1886, 870 pp. $8.40.


[1] Earlier volumes of the Mineral Resources of the United States also contain discussions relating to the lead and zinc industries of the United States.

EMMONS, S. F., Economic geology of the Mercur mining district, Utah: Sixteenth Ann. Rept., pt. 2, 1895, pp. 349–369. $1.25.

——— The mines of Custer County, Colo.: Seventeenth Ann. Rept., pt. 2, 1896, pp. 411–472. $2.35.

EMMONS, S. F., and IRVING, J. D., Downtown district of Leadville, Colo.: Bull. 320, 1907, 72 pp.

EMMONS, W. H., Some ore deposits in Maine and the Milan mine, New Hampshire: Bull. 432, 1910, 62 pp.

GRANT, U. S., Zinc and lead deposits of southwestern Wisconsin: Bull. 260, 1905, pp. 304–310. 40c.

GRANT, U. S., and BURCHARD, E. F., Lancaster-Mineral Point folio (No. 145), Geol. Atlas U. S., 1907. 25c.

HAGUE, ARNOLD, Geology of the Eureka district, Nevada: Mon. XX, 1892, 419 pp. $5.25.

HAHN, O. H., The smelting of argentiferous lead ores in the far West: Mineral Resources U. S. for 1882, 1883, pp. 324–345. 50c.

HOFFMAN, H. O., Recent improvements in desilverizing lead in the United States: Mineral Resources U. S. for 1883–84, 1885, pp. 462–473. 60c.

ILES, M. W., Lead slags: Mineral Resources U. S. for 1883–84, 1885, pp. 440–462. 60c.

IRVING, J. D., Ore deposits of the northern Black Hills: Bull. 260, 1905, pp. 50–77. 40c.

——— Ore deposits in the vicinity of Lake City, Colo.: Bull. 260, 1905, pp. 78–84. 40c.

IRVING, J. D., and BANCROFT, HOWLAND, Geology and ore deposits in the vicinity of Lake City, Colo.: Bull. 478, 1911, 128 pp.

IRVING, J. D., and EMMONS, S. F., Economic resources of northern Black Hills: Prof. Paper 26, 1904, pp. 53–212.

KEITH, ARTHUR, Maynardville folio (No. 75), Geol. Atlas U. S., 1901. 25c.

——— Recent zinc mining in East Tennessee: Bull. 225, 1904, pp. 208–213. 35c.

LINDGREN, WALDEMAR, The mining districts of the Idaho Basin and the Boise Ridge, Idaho: Eighteenth Ann. Rept., pt. 3, 1898, pp. 625–736. $2.15.

——— The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho: Twentieth Ann. Rept., pt. 3, 1900, pp. 75–256. $1.50.

——— A geological reconnaissance across the Bitterroot Range and Clearwater Mountains in Montana and Idaho: Prof. Paper 27, 1904, 123 pp.

——— The Tres Hermanas mining district, New Mexico: Bull. 380, 1909, pp. 123–128.

——— Resources of the United States in gold, silver, copper, lead, and zinc: Bull. 394, 1909, pp. 114–156.

LINDGREN, WALDEMAR, and GRATON, L. C., Mineral deposits of New Mexico: Bull. 285, 1906, pp. 74–86. 60c.

LINDGREN, WALDEMAR, GRATON, L. C., and GORDON, C. H., The ore deposits of New Mexico: Prof. Paper 68, 1910, 361 pp.

MACDONALD, D. F., Economic features of northern Idaho and northwestern Montana: Bull. 285, 1906, pp. 41–52. 60c.

MCCASKEY, H. D., Gold, silver, copper, lead, and zinc in the Eastern States (mine production): Mineral Resources U. S. for 1910, pt. 1, 1911, pp. 675–691.

MCCASKEY, H. D., and others: Gold, silver, copper, lead, and zinc in the Western States in 1910 (mine production): Mineral Resources U. S. for 1910, pt. 1, 1911, pp. 305–610.

PEPPERBERG, L. J., Notes on the mineral deposits of the Bearpaw Mountains, Montana: Bull. 430, 1910, pp. 135–146.

RANSOME, F. L., Report on the economic geology of the Silverton quadrangle, Colorado: Bull. 182, 1901, 265 pp. 50c.

——— The ore deposits of the Rico Mountains, Colorado: Twenty-second Ann. Rept., pt. 2, 1902, pp. 229–398.

——— Geology and ore deposits of the Breckenridge district, Colorado: Prof. Paper 75, 1911, 187 pp.

RANSOME, F. L., and CALKINS, F. C., Geology and ore deposits of the Cœur d'Alene district, Idaho: Prof. Paper 62, 1908, 203 pp. 85c.

RICHARDS, R. W., Notes on lead and copper deposits in the Bear River Range, Idaho and Utah: Bull. 470, 1911, pp. 177–187.

SCHRADER, F. C., Mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz.: Bull. 340, 1908, pp. 53–84.

——— The mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz.: Bull. 397, 1909, 226 pp.

Siebenthal, C. E., Mineral resources of northeastern Oklahoma: Bull. 340, 1908, pp. 187–228.

——— Lead: Mineral Resources U. S. for 1910, pt. 1, 1911, pp. 221–259.

——— Zinc: Mineral Resources U. S. for 1910, pt. 1, 1911, pp. 261–304.

Smith, G. O., Note on a mineral prospect in Maine: Bull. 315, 1907, pp. 118–119.

Smith, W. S. T., Lead and zinc deposits of the Joplin district, Missouri-Kansas: Bull. 213, 1903, pp. 197–204. 25c.

Smith, W. S. T., and Siebenthal, C. E., Joplin district folio (No. 148), Geol. Atlas U. S., 1907. 50c.

Spencer, A. C., The Mine Hill and Sterling Hill zinc deposits of Sussex County, N. J.: Ann. Rept. Geol. Survey New Jersey for 1908, 1909, pp. 25–52.

Spencer, A. C., Salisbury, R. D., and Kümmel, H. B., Franklin Furnace folio (No. 161), Geol. Atlas U. S., 1908. 25c.

Spurr, J. E., Geology of the Aspen mining district, Colorado, with atlas: Mon. XXXI, 1898, 260 pp. $3.60.

——— The ore deposits of Monte Cristo, Wash.: Twenty-second Ann. Rept., pt. 2, 1902, pp. 777–866.

——— Descriptive geology of Nevada south of the fortieth parallel and adjacent portions of California: Bull. 208, 1903, 229 pp.

Spurr, J. E., and Garrey, G. H., Preliminary report on the ore deposits of the Georgetown mining district, Colorado: Bull. 260, 1905, pp. 99–120. 40c.

——— The Idaho Springs mining district, Colorado: Bull. 285, 1906, pp. 35–40. 60c.

——— Economic geology of the Georgetown quadrangle, together with the Empire district, Colorado, with general geology by S. H. Ball: Prof. Paper 63, 1908, 422 pp.

Tower, G. W., and Smith, G. O., Geology and mining industry of the Tintic district, Utah: Nineteenth Ann. Rept., pt. 3, 1899, pp. 601–767. $2.25.

Tower, G. W., Smith, G. O., and Emmons, S. F., Tintic special folio (No. 65), Geol. Atlas U. S., 1900. 25c.

Ulrich, E. O., and Smith, W. S. T., Lead, zinc, and fluorspar deposits of western Kentucky: Bull. 213, 1903, pp. 205–213 (25c.); Prof. Paper 36, 1905, 218 pp.

Weed, W. H., Fort Benton folio (No. 55), Geol. Atlas U. S., 1899. 25c.

——— Little Belt Mountains folio (No. 56), Geol. Atlas U. S., 1899. 25c.

——— Geology of the Little Belt Mountains, Montana, with notes on the mineral deposits of the Neihart, Barker, Yogo, and other districts: Twentieth Ann. Rept., pt. 3, 1900, pp. 271–461. $1.50.

Weed, W. H., and Barrell, Joseph, Geology and ore deposits of the Elkhorn mining district, Jefferson County, Mont.: Twenty-second Ann. Rept., pt. 2, 1901, pp. 399–549. $2.25.

Weed, W. H., and Pirsson, L. V., Geology of the Castle Mountains mining district: Bull. 139, 1896, 164 pp. 15c.

Winslow, A., The disseminated lead ores of southeastern Missouri: Bull. 132, 1896, 31 pp. 5c.

Wolff, J. E., Zinc and manganese deposits of Franklin Furnace, N. J.: Bull. 213, 1903, pp. 214–217. 25c.

# CADMIUM.

By C. E. Siebenthal.

## INTRODUCTION.

A brief account of the production, resources, metallurgy, and uses of cadmium was given as a chapter in Mineral Resources for 1908, and the reader is referred to that paper for further information.

The chief output of cadmium comes from the zinc-producing regions of Silesia, where it is recovered as a by-product in the distillation of zinc. Recently in England a little cadmium has been recovered in the purification of the solution of zinc sulphate in the manufacture of lithopone.

## PRODUCTION.

Cadmium in metallic form has been recovered in the United States since 1907 by a single producer and since the latter part of 1910 by two producers. A considerable quantity of the pigment, cadmium sulphide, was also produced in 1911. No authoritative statement of the method of recovering metallic cadmium has yet been made. The metallurgical method employed abroad has generally been fractional distillation of zinc ores. Cadmium has also been recovered as a by-product in the manufacture of lithopone, as noted above. Among the possible sources of cadmium in a general chemical works would be the slime left in the production of zinc chloride from zinc scrap, skimmings, etc., or from low-grade roasted zinc ores. As dilute hydrochloric acid dissolves zinc in preference to cadmium, the cadmium content of the zinc scrap, skimmings, etc., is left behind in the slimes. From these slimes the cadmium may be recovered by distillation, by electrolysis, or by purely chemical methods.

Bain [1] noted the presence of cadmium in the zinc ores of the Leadville and Kokomo districts of Colorado, and Guyard [2] gives analyses of flue, chamber, and bag-house dust from Leadville, which show small percentages of cadmium in each. At the time Guyard's analyses were made the ores being smelted at Leadville were mostly carbonates, with little or no sulphides and only a trace of zinc. In the extensive zinc-lead sulphide deposits developed in later years the cadmium content, as shown by Bain, is much higher, so that the bag-house dust from Leadville ores must now show considerably higher proportions of cadmium. In 1908, W. R. Ingalls stated [3] that noteworthy quantities of cadmium occur in "fume" from lead

[1] Bain, H. F., Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, p. 384.
[2] Guyard, Antony, Geology and mining district of Leadville, Colo.: Mon. U. S. Geol. Survey, vol. 12, 1886, pp. 712, 715, 717.
[3] Mineral Industry, 1907, p. 126.

smelting furnaces collected by bag filtration in Colorado, and that the utilization of this material as a source of cadmium had been considered, though negatived on account of lack of market for the metal.

In smelting such ores the cadmium will distill over from the blast furnaces to the bag house, where it will be caught with arsenic, lead, and antimony. When the burnt fume from the bag house is charged back into the blast furnaces most of the lead and antimony will be recovered in metallic form, but the arsenic and cadmium will again go over to the bag house. In time the fume will be very much enriched in cadmium and arsenic. The difference in temperature at which arsenic and cadmium volatilize allows an easy separation of these metals, and after separation the cadmium residue can be reduced to metallic form without difficulty. The cadmium may be recovered by distillation or by an electrolytic process.

Inasmuch as the production is limited to two firms, the quantity and value of the output can not be given. The local production in 1907 was nearly sufficient to supply the domestic demand—a fact shown by the small imports for that year—but the next year the quantity of cadmium imported was about doubled, and in 1909–1911 the imports of cadmium were back at the old figures which obtained before the beginning of the production of cadmium in the United States. The domestic production nevertheless was considerably larger in 1911 than in any previous year.

## PRODUCTION IN GERMANY.

The following table gives the production of cadmium in Upper Silesia from 1882 to 1911, inclusive.

*Quantity and value of cadmium produced in Germany, 1882–1911.*[a]

| Year. | Quantity. | Value. | Average price per pound. | Year. | Quantity. | Value. | Average price per pound. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | | | *Pounds.* | | |
| 1882 | 7,762 | | | 1897 | 34,231 | $42,037.23 | $1.23 |
| 1883 | 5,333 | | | 1898 | 32,954 | 29,666.70 | .90 |
| 1884 | 6,118 | | | 1899 | 21,693 | 15,544.26 | .72 |
| 1885 | 7,222 | | | 1900 | 29,835 | 19,524.81 | .65 |
| 1886 | 10,944 | $8,710.56 | $0.80 | 1901 | 28,977 | 19,754.71 | .68 |
| 1887 | 16,140 | 11,542.29 | .72 | 1902 | 27,833 | 15,132.00 | .54 |
| 1888 | 10,573 | 5,439.49 | .51 | 1903 | 36,519 | 19,242.06 | .53 |
| 1889 | 11,327 | 4,621.71 | .41 | 1904 | 55,655 | 32,882.32 | .59 |
| 1890 | 9,167 | 3,477.18 | .38 | 1905 | 54,163 | 35,240.18 | .65 |
| 1891 | 6,281 | 2,423.32 | .39 | 1906 | 47,368 | 36,083.89 | .76 |
| 1892 | 7,055 | 2,713.20 | .38 | 1907 | 72,639 | 60,757.35 | .84 |
| 1893 | 11,651 | 5,198.87 | .45 | 1908 | 72,741 | 48,590.21 | .67 |
| 1894 | 15,095 | 8,393.31 | .56 | 1909 | 81,982 | 46,777.16 | .57 |
| 1895 | 15,095 | 9,052.04 | .60 | 1910 | 90,516 | 39,309.51 | .43 |
| 1896 | 23,514 | 19,453.64 | .83 | 1911 | 93,861 | 53,372.45 | .57 |

[a] Recalculated to pounds and dollars from Statistik des Oberschlesischen Berg- und Hüttenmännischen Vereins, as quoted by Jensch, from Vierteljahreshefte zur Statistik des Deutschen Reichs and from Statistisches Jahrbuch für den Preussischen Staat.

## IMPORTS.

Cadmium is imported into the United States as metallic stick cadmium and as the pigment, cadmium sulphide (CdS), known as "cadmium yellow." The former is free of duty; the latter is dutiable at 30 per cent ad valorem. The value of the imports for consumption of metallic cadmium for 1903 to 1911, inclusive, is given

in the table below, which is taken from the records of the Bureau of Statistics. The quantities are not there recorded previous to July, 1909, and for the period preceding that time they have been computed by dividing the values of the imports by the average price of cadmium for the corresponding years in Germany, from which country the cadmium was imported. The quantity of cadmium imported as a pigment and the value thereof are not kept separately by the Bureau of Statistics.

*Cadmium imported for consumption into the United States, 1903–1911, in pounds.*

| Year. | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1903 | [a] 8,679 | $4,565 | 1908 | [a] 3,567 | $2,390 |
| 1904 | [a] 7,655 | 4,524 | 1909, first half | [a] 6,659 | 4,559 |
| 1905 | [a] 8,138 | 5,298 | 1909, second half | 2,203 | |
| 1906 | [a] 13,808 | 10,522 | 1910 | 4,060 | 2,295 |
| 1907 | [a] 1,953 | 1,633 | 1911 | 5,367 | 3,870 |

[a] Prior to July, 1909, the quantities are computed as noted above.

## PRICES.

The domestic quotations on cadmium in 1911, as reported in the Engineering and Mining Journal, ranged from 60 to 85 cents per pound, f. o. b. New York, the price varying according to quantity. The average price for the year, based on sales, was a little less than 70 cents per pound.

According to Paul Speier, of Breslau, Germany, the price of 99½ per cent cadmium sticks started the year at 600 marks per 100 kilograms (64.8 cents per pound) f. o. b. cars at the works. In response to a comparatively good demand the price gradually rose to 700 marks per 100 kilograms (75.6 cents per pound) and fluctuated between that figure and 750 marks (81 cents per pound) until the close of the year

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE WESTERN STATES.

(MINE PRODUCTION.)

## INTRODUCTION.

By H. D. McCaskey.

The following table shows at a glance the mine production of gold, silver, copper, lead, and zinc metals and ores in the Western States and Alaska in 1911:

*Mine production of gold, silver, copper, lead, and zinc in the Western States and Alaska in 1911.*

| State. | Ore sold or treated. | Gold. | | Silver. | | Copper. | |
|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | *Short tons.* | *Fine ounces.* | | *Fine ounces.* | | *Pounds.* | |
| Alaska | 1,663,379 | 815,276.26 | $16,853,256 | 460,231 | $243,922 | 27,267,878 | $3,408,485 |
| Arizona | 4,567,139 | 165,950.58 | 3,430,503 | 3,276,571 | 1,736,583 | 306,141,538 | 38,267,692 |
| California | 2,797,261 | 954,869.67 | 19,738,908 | 1,270,445 | 673,336 | 36,316,136 | 4,539,517 |
| Colorado | 2,377,936 | 919,220.54 | 19,001,975 | 7,330,168 | 3,884,989 | 8,024,488 | 1,003,061 |
| Idaho | 2,170,897 | 66,389.22 | 1,372,387 | 8,196,136 | 4,343,952 | 5,152,937 | 644,117 |
| Montana | 4,940,303 | 179,498.87 | 3,710,571 | 11,985,196 | 6,352,154 | 272,847,705 | 34,105,963 |
| Nevada | 4,132,721 | 880,105.58 | 18,193,397 | 13,184,601 | 6,987,839 | 67,377,518 | 8,422,190 |
| New Mexico | 232,699 | 36,900.84 | 762,808 | 1,354,540 | 717,906 | 4,057,040 | 507,130 |
| Oregon | 98,558 | 30,641.06 | 633,407 | 45,221 | 23,967 | 93,136 | 11,642 |
| South Dakota | 1,946,127 | 359,903.90 | 7,439,874 | 203,755 | 107,990 | ..... | ..... |
| Texas | 21,732 | 1.02 | 21 | 424,394 | 224,929 | ..... | ..... |
| Utah | 7,268,530 | 227,217.28 | 4,696,998 | 12,473,787 | 6,611,107 | 146,960,827 | 18,370,103 |
| Washington | 82,305 | 41,006.37 | 847,677 | 243,781 | 129,204 | 318,207 | 39,776 |
| Wyoming | 3,491 | 928.80 | 19,200 | 725 | 384 | 118,584 | 14,823 |
| Total, 1911 | 32,303,078 | 4,677,909.99 | 96,700,982 | 60,449,551 | 32,038,262 | 874,675,994 | 109,334,499 |
| Total, 1910 | 29,452,725 | 4,575,927.94 | 94,592,826 | 57,139,412 | 30,855,281 | 847,536,107 | 107,637,084 |

| State. | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | |
| Alaska | ..... | ..... | ..... | ..... | $20,505,663 |
| Arizona | 10,274,552 | $462,355 | 4,562,984 | $260,090 | 44,157,223 |
| California | 1,398,111 | 62,915 | 2,807,035 | 160,001 | 25,174,677 |
| Colorado | 69,679,289 | 3,135,568 | 94,607,456 | 5,392,625 | 32,418,218 |
| Idaho | 272,556,525 | 12,265,044 | 8,340,249 | 475,394 | 19,100,894 |
| Montana | 6,431,575 | 289,421 | 43,810,145 | 2,497,178 | 46,955,287 |
| Nevada | 3,263,657 | 146,865 | 3,548,032 | 202,238 | 33,952,529 |
| New Mexico | 2,966,222 | 133,480 | 10,237,176 | 583,519 | 2,704,843 |
| Oregon | ..... | ..... | ..... | ..... | 669,016 |
| South Dakota | 64,311 | 2,894 | ..... | ..... | 7,550,758 |
| Texas | 122,800 | 5,526 | ..... | ..... | 230,476 |
| Utah | 136,496,750 | 6,142,354 | 17,840,261 | 1,016,895 | 36,837,457 |
| Washington | 848,584 | 38,186 | 20,590 | 1,174 | 1,056,017 |
| Wyoming | ..... | ..... | ..... | ..... | 34,407 |
| Total, 1911 | 504,102,376 | 22,684,608 | 185,773,928 | 10,589,114 | 271,347,465 |
| Total, 1910 | 447,922,476 | 19,708,588 | 156,978,149 | 8,476,820 | 261,270,599 |

The area covered by these figures and the following report, in which the mine production of the Western States and Alaska is treated in detail, lies west of the one hundred and third meridian, which passes through western South Dakota and eastern Colorado, between New Mexico and northern Texas, and through trans-Pecos or western Texas. It includes all mines and mining districts of the United States except those of the Central and the Eastern States, the corresponding mine production of which is covered by separate reports of the United States Geological Survey.

This area embraces physiographic and geologic regions and ore deposits of various metallogenetic provinces and of classification according to genesis or according to form that need not be reviewed in detail here. An outline map on the scale of 40 miles to the inch and showing the location and principal metals of the mining districts of this area was published in the Western States mines report of the Survey for 1907, and copies of this map can still be had at cost from the Director of the United States Geological Survey, Washington, D. C.

Bulletin 507 of the Survey, "The mining districts of the Western States, by James M. Hill, with a geologic introduction by Waldemar Lindgren," contains revised maps on the same scale, lists of mining districts showing locations, principal ores produced, brief notes on character of deposits, and references to Survey maps and reports on each district. A masterly summary of the geology of the ore deposits of the Western States is given by Waldemar Lindgren. This bulletin can also be had on application to the Director of the Survey.

In addition to the three annual mines reports on gold, silver, copper, lead, and zinc for the (1) Western States, (2) Central States, and (3) Eastern States the Survey publishes annually separate reports for the entire country on the general subjects of (1) gold and silver, (2) copper, (3) lead, and (4) zinc and cadmium. Copies of these can be had on application to the Director of the Survey.

In the following sections will be found, among new features, rearrangement of detail from the reports of former years, details of classification of crude ore and concentrates, lists of mills, showing equipment and capacity of each, and figures, obtained for the first time, showing quantitatively the relative production of the precious metals by amalgamation and cyanidation. The labor in securing and verifying this new information has been considerable, and much credit is due the authors contributing it. An important feature of future statistical work would seem to be the compilation of figures from time of earliest operation to date for each important mining district and State. In part this information is now available, but the labor of completing it will be considerable and the results can only be published from year to year as fast as they become final.

Of the total mine production of gold in the United States in 1911, valued at $97,054,791, the Western States supplied $96,700,982, or 99.6 per cent, and of the total mine production of silver of 61,108,791 fine ounces the Western States supplied 60,449,551 ounces, or 98.9 per cent. Of the total mine production of 1,114,764,197 pounds of copper in the United States in 1911 the Western States are credited with 874,675,994 pounds, or 78.5 per cent, the remainder being produced chiefly in Michigan, but also in Tennessee. Of the total mine production of lead in the United States of 882,377,498 pounds in

1911 the Western States produced 504,102,376 pounds, or 57.1 per cent, the Central States (mainly Missouri), 377,338,000 pounds, or 42.8 per cent, and the Eastern States the small remainder. Finally, of the total mine production of zinc (all figured as spelter) of 688,629,486 pounds in 1911 the Western States supplied 185,773,928 pounds, or 27 per cent; the Central States (mainly Missouri), 345,396,000 pounds, or 50 per cent; and the Eastern States (mainly New Jersey), 159,351,558 pounds, or 23 per cent. The total value of the mine output of these five metals in 1911 was $11,787,942 in the Eastern States, $64,519,444 in the Central States, and $271,347,465 in the Western States, or $347,654,851 for the mine production of gold, silver, copper, lead, and zinc in the United States in 1911 against a corresponding value of $334,264,737 in 1910.

In the combined mine production in the Western States of gold, silver, copper, lead, and zinc in 1911, (1) Montana leads in value, with $46,955,287, followed by (2) Arizona with $44,157,223, (3) Utah with $36,837,457, (4) Nevada with $33,952,529, (5) Colorado with $32,418,218, (6) California with $25,174,677, (7) Alaska with $20,505,663, and (8) Idaho with $19,100,894.

In the mine production of gold in the United States in 1911 (1) California leads in value with $19,738,908, followed by (2) Colorado with $19,001,975, (3) Nevada with $18,193,397, (4) Alaska with $16,853,256, and (5) South Dakota with $7,439,874.

In the mine production of silver in the United States in 1911 (1) Nevada leads with 13,184,601 fine ounces, followed by (2) Utah with 12,473,787 ounces, (3) Montana with 11,985,196 ounces, (4) Idaho with 8,196,136 ounces, and (5) Colorado with 7,330,168 ounces.

In the mine production of copper in 1911 in the United States (1) Arizona leads with 306,141,538 pounds, followed by (2) Montana with 272,847,705 pounds, (3) Michigan, with 219,840,201 pounds, (4) Utah with 146,960,827 pounds, and (5) Nevada with 67,377,518 pounds.

In the mine production of lead in 1911 in the United States, (1) Missouri ranks first with 357,736,000 pounds, followed by (2) Idaho with 272,556,525 pounds, (3) Utah with 136,496,750 pounds, (4) Colorado with 69,679,289 pounds, and (5) Arizona with 10,274,552 pounds.

In the mine production of zinc in 1911 in the United States (1) Missouri leads with 245,030,000 pounds, followed by (2) New Jersey with 154,890,900 pounds, (3) Colorado with 94,607,456 pounds, (4) Wisconsin with 57,548,000 pounds, and (5) Montana with 43,810,145 pounds.

Analysis of the foregoing paragraphs shows that of the first five places in rank of mine production of each of the five metals in the entire United States in 1911, the Western States hold 20 of the 25 places, only 4 places, including third place in copper production, first place in lead production, and first and fourth places in zinc production, going to the Central States, and only 1 place, that of second in rank of zinc production, going to the Eastern States.

The data for this report on the Western States are confidential returns to the Survey from the producers, and these are checked and verified by other data, both confidential and published. These data are reported to, verified, interpreted, and compiled by A. H. Brooks, in charge of the Division of Alaskan Mineral Resources, for Alaska;

Charles W. Henderson, in charge of the Denver office of the Division of Mineral Resources, for Colorado, New Mexico, South Dakota, Texas, and Wyoming; V. C. Heikes, in charge of the Salt Lake City office (assisted by C. N. Gerry), for Arizona, Idaho, Montana, Nevada, Utah, and Washington; and Charles G. Yale, in charge of the San Francisco office, for California and Oregon. For final checking of all figures by J. P. Dunlop and final preparation of manuscript for the printer by W. T. Thom, cordial acknowledgment is made.

Cooperation with the Survey by the mining and metallurgical industries, by merchants, bankers, and transportation officials, by the Bureau of the Mint, by the Post Office Department, by the Bureau of Foreign and Domestic Commerce of the Department of Commerce and Labor, and by other officials, public and private, is also gratefully acknowledged.

The average prices used by the Survey in calculating the values of the metals for 1911 in this and other reports of this volume are as follows:

| | | |
|---|---|---|
| Gold | per fine ounce | $20.671834625323 |
| Silver | do | .53 |
| Copper | per pound | .125 |
| Lead | do | .045 |
| Zinc (spelter) | do | .057 |

The classification of ores adopted is necessarily arbitrary in part. An ore is generally understood to be worked at a profit for one or more metals. The complex nature of western ores especially and the insensible gradations from one to another render essential some fixed measures for the terminology used. The dry or siliceous ores comprise gold and silver ores proper. These can not conveniently be subdivided between gold ores and silver ores, for both metals occur together in all proportions, and the tables are of primary classification rather than of detail. The quantity of purely silver ores and the number of mines producing them are also relatively small. The copper ores include those containing 2½ per cent or more of copper, or below this percentage in the case of ores of the great disseminated copper deposits. The lead ores are those containing 4½ per cent or more of lead, and the zinc ores those containing 25 per cent or more of zinc, both irrespective of their precious-metal content.

## ALASKA.

By Alfred H. Brooks.[1]

### INTRODUCTION.

The metalliferous mining industry of Alaska had a very successful year in 1911. Much progress was made in placer and lode gold mining. The copper production was very large, and the outlook for the development of the tin deposits in the Seward Peninsula is more promising than it ever has been. On the other hand, there were no advances made in the exploration of the coal fields, for this phase of the mining industry still awaits the inauguration of a definite policy in regard to the disposition of the public coal lands. Therefore, the same

[1] Aid has been rendered in the preparation of this report by E. M. Aten, who has assisted in the collection of statistics from mines. The data on mining development here presented are all taken from Bulletin 520, which deals with the region in a more detailed way. See Brooks, Alfred H., and others, Mineral resources of Alaska, 1911: Bull. U. S. Geol. Survey No. 520, 1912.

hesitation exists, as in previous years, in all enterprises depending on the opening of the coal fields. These include not only coal-mining ventures, but railway construction and metalliferous mining and other industries which depend on cheap fuel for their successful prosecution. As a result of the delay in opening the coal fields most of the railways, many of the lode mines, and a large part of the dredges on Seward Peninsula are using or preparing to use California petroleum, as fuel. No change has been made in the mineral-land laws, which still greatly hamper the placer mining industry. One hundred and sixty acre claims are still located and held for a year or more without development and then by only $100 worth of annual assessment work. These conditions are favorable only to the speculator and discourage the bona fide miner and prospector.

The advance of the Alaska mining industry is illustrated by the fact that the copper output of 1911 was more than six times as great as that of 1910. This increase is to be credited to the Prince William Sound and Kotsina-Chitina districts. The first shipment of ore from the latter district was made in April, 1911.

The gold output also increased in 1911, owing mainly to the fact that the production of the placer mines of the Iditarod-Innoko region was more than three times, and that of the Hot Springs district was more than twice, as large as the outputs of these camps in 1910. On the other hand, the gold production from both the Fairbanks and the Seward Peninsula placers was less than that of 1910.

Aside from the increased production of copper and gold, the most important event of the year was the opening of the Copper River region by the completion of the railway into it. The industries already stimulated by this line strikingly illustrate the importance of railway communication in Alaska.

Although a large part of the gold still comes from the placers, much progress was made during 1911 in paving the way for an increased output from auriferous lodes. This work was carried on in most of the gold-bearing areas of Alaska, but the most notable advances were in the Juneau, Valdez, Kenai Peninsula, Willow Creek, and Fairbanks districts. Dredge mining also made great progress, notably in the Nome region. Twenty-seven dredges were operated in Alaska for the whole or a part of the open season of 1911. In addition to those operated, half a dozen were in process of construction.

As in previous years, attempt has been made to base statistics of production, so far as possible, on statements of individual producers—the only reliable source of information. Though the cordial cooperation of most of the important mine operators has been secured, there are still a few large producers of placer gold and many smaller ones who neglect to reply to the request for information. In connection with this work the writer is under special obligations for valuable information to the Director of the United States Mint, to the collectors of the customs service, to the many United States commissioners in the Territory, to officials of banks and of transportation companies, and to prominent residents. All these data have been carefully sifted, and the accompanying figures are based upon them. The limit of error of the statement of the total gold production of the Territory is believed to be within 2 per cent. In the crediting of the proper amounts to individual districts, however, the error may be in some cases as high as 8 per cent.

The following table is an estimate of the total gold, silver, and copper production of Alaska since the beginning of auriferous mining in 1880. For the early years the figures are probably far from being correct, but they are based on the best information now available.

*Production of gold, silver, and copper in Alaska, 1880–1911.*

| Year. | Gold. | | Silver. | | Copper. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Commercial value. | Quantity. | Value. |
| | *Fine ounces.* | | *Fine ounces.* | | *Pounds.* | |
| 1880 | 967 | $20,000 | | | 3,933 | $826 |
| 1881 | 1,935 | 40,000 | | | | |
| 1882 | 7,256 | 150,000 | | | | |
| 1883 | 14,561 | 301,000 | | | | |
| 1884 | 9,723 | 201,000 | 10,320 | $11,146 | | |
| 1885 | 14,512 | 300,000 | | | | |
| 1886 | 21,575 | 446,000 | | | | |
| 1887 | 32,653 | 675,000 | | | | |
| 1888 | 41,119 | 850,000 | 2,320 | 2,181 | | |
| 1889 | 43,538 | 900,000 | 8,000 | 7,490 | | |
| 1890 | 36,862 | 762,000 | 7,500 | 6,071 | | |
| 1891 | 43,538 | 900,000 | 8,000 | 7,920 | | |
| 1892 | 52,245 | 1,080,000 | 8,000 | 7,000 | | |
| 1893 | 50,213 | 1,038,000 | 8,400 | 6,570 | | |
| 1894 | 62,017 | 1,282,000 | 22,261 | 14,257 | | |
| 1895 | 112,642 | 2,328,500 | 67,200 | 44,222 | | |
| 1896 | 138,401 | 2,861,000 | 145,300 | 99,087 | | |
| 1897 | 118,011 | 2,439,500 | 116,400 | 70,741 | | |
| 1898 | 121,760 | 2,517,000 | 92,400 | 54,575 | | |
| 1899 | 270,997 | 5,602,000 | 140,100 | 84,276 | | |
| 1900 | 395,030 | 8,166,000 | 73,300 | 45,494 | | |
| 1901 | 335,369 | 6,932,700 | 47,900 | 28,598 | 250,000 | 40,000 |
| 1902 | 400,709 | 8,283,400 | 92,000 | 48,590 | 360,000 | 41,400 |
| 1903 | 420,069 | 8,683,600 | 143,600 | 77,843 | 1,200,000 | 156,000 |
| 1904 | 443,115 | 9,160,000 | 198,700 | 114,934 | 2,043,586 | 275,676 |
| 1905 | 756,101 | 15,630,000 | 132,174 | 80,165 | 4,805,236 | 749,617 |
| 1906 | 1,066,030 | 22,036,794 | 203,500 | 136,345 | 5,871,811 | 1,133,260 |
| 1907 | 936,044 | 19,349,743 | 149,784 | 98,857 | 6,308,786 | 1,261,757 |
| 1908 | 933,290 | 19,292,818 | 135,672 | 71,906 | 4,585,362 | 605,267 |
| 1909 | 987,417 | 20,411,716 | 147,950 | 76,934 | 4,124,705 | 536,211 |
| 1910 | 780,131 | 16,126,749 | 157,850 | 85,239 | 4,241,689 | 538,695 |
| 1911 | 815,276 | 16,853,256 | 460,231 | 243,922 | 27,267,878 | 3,408,485 |
| Total | 9,463,106 | 195,619,776 | 2,578,862 | 1,524,363 | 61,062,986 | 8,747,194 |

## PRODUCTION.

The production and value of gold, silver, and copper in Alaska for 1910 and 1911 are shown in the following table:

*Mine production of gold, silver, and copper in Alaska, 1910–11.*

| | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....ounces.. | 780,131.48 | $16,126,749 | 815,276.26 | $16,853,256 | + 35,144.78 | + $726,507 |
| Silver.....do.... | 157,850 | 85,239 | 460,231 | 243,922 | + 302,381 | + 158,683 |
| Copper.....pounds.. | 4,241,689 | 538,695 | 27,267,878 | 3,408,485 | +23,026,189 | +2,869,790 |

The value of the gold production of Alaska in 1911 is estimated at $16,853,256 and that of silver at $243,922 and the number of ounces of gold at 815,276.48 and of silver at 460,231. In 1910 the output of gold was valued at $16,126,749. The copper output of Alaska for

1911 was 27,267,878 pounds, valued at $3,408,485, an increase from 1910 of 23,869,790 pounds.

Comparison is made in the following table between the gold production of 1911 and 1910, by districts:

*Value of gold production in Alaska in 1910 and 1911, by districts.*

| District. | 1910 | 1911 | Increase (+) or decrease (−). |
|---|---|---|---|
| Pacific coast belt, including southeastern Alaska and Prince William Sound | $4,182,730 | $4,265,573 | + $82,843 |
| Copper River and Cook Inlet region | 351,630 | 313,538 | − 38,092 |
| Yukon and Kuskokwim basins | 8,062,389 | 9,139,145 | +1,076,756 |
| Seward Peninsula and northwestern Alaska | 3,530,000 | 3,135,000 | − 395,000 |
| Total | 16,126,749 | 16,853,256 | + 726,507 |

The following table shows the production of gold, silver, and copper in 1911, by districts:

*Mine production of gold, silver, and copper in Alaska in 1911, by districts.*

| District. | Gold. | | Silver. | | Copper. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Pacific coast belt, including southeastern Alaska and Prince William Sound | *Fine ounces.* 206,347.09 | $4,265,573 | *Fine ounces.* 352,168 | $186,649 | *Pounds.* 27,267,878 | $3,408,485 |
| Copper River and Cook Inlet region | 15,167.40 | 313,538 | | | | |
| Yukon and Kuskokwim Basins | 442,106.14 | 9,139,145 | 89,695 | 47,538 | ..... | ..... |
| Seward Peninsula and northwestern Alaska | 151,655.63 | 3,135,000 | 18,368 | 9,735 | ..... | ..... |
| Total | 815,276.26 | 16,853,256 | 460,231 | 243,922 | 27,267,878 | 3,408,485 |

*Value of gold production of Alaska, with approximate distribution, 1880–1911.*

| Year. | Pacific coast belt. | Copper River and Cook Inlet region. | Yukon basin. | Seward Peninsula and northwestern Alaska. | Total. |
|---|---|---|---|---|---|
| 1880 | $20,000 | ..... | ..... | ..... | $20,000 |
| 1881 | 40,000 | ..... | ..... | ..... | 40,000 |
| 1882 | 150,000 | ..... | ..... | ..... | 150,000 |
| 1883 | 300,000 | ..... | $1,000 | ..... | 301,000 |
| 1884 | 200,000 | ..... | 1,000 | ..... | 201,000 |
| 1885 | 275,000 | ..... | 25,000 | ..... | 300,000 |
| 1886 | 416,000 | ..... | 30,000 | ..... | 446,000 |
| 1887 | 645,000 | ..... | 30,000 | ..... | 675,000 |
| 1888 | 815,000 | ..... | 35,000 | ..... | 850,000 |
| 1889 | 860,000 | ..... | 40,000 | ..... | 900,000 |
| 1890 | 712,000 | ..... | 50,000 | ..... | 762,000 |
| 1891 | 800,000 | ..... | 100,000 | ..... | 900,000 |
| 1892 | 970,000 | ..... | 110,000 | ..... | 1,080,000 |
| 1893 | 838,000 | ..... | 200,000 | ..... | 1,038,000 |
| 1894 | 882,000 | ..... | 400,000 | ..... | 1,282,000 |
| 1895 | 1,569,500 | $50,000 | 709,000 | ..... | 2,328,500 |
| 1896 | 1,941,000 | 120,000 | 800,000 | ..... | 2,861,000 |
| 1897 | 1,799,500 | 175,000 | 450,000 | $15,000 | 2,439,500 |
| 1898 | 1,892,000 | 150,000 | 400,000 | 75,000 | 2,517,000 |
| 1899 | 2,152,000 | 150,000 | 500,000 | 2,800,000 | 5,602,000 |
| 1900 | 2,606,000 | 160,000 | 650,000 | 4,750,000 | 8,166,000 |
| 1901 | 2,072,000 | 180,000 | 550,000 | 4,130,700 | 6,932,700 |
| 1902 | 2,546,600 | 375,000 | 800,000 | 4,561,800 | 8,283,400 |

*Value of gold production of Alaska, with approximate distribution, 1880–1911*—Con.

| Year. | Pacific coast belt. | Copper River and Cook Inlet region. | Yukon basin. | Seward Peninsula and northwestern Alaska. | Total. |
|---|---|---|---|---|---|
| 1903 | $2,843,000 | $375,000 | $1,000,000 | $4,465,600 | $8,683,600 |
| 1904 | 3,195,400 | 500,000 | 1,300,000 | 4,164,600 | 9,160,000 |
| 1905 | 3,430,000 | 500,000 | 6,900,000 | 4,800,000 | 15,630,000 |
| 1906 | 3,454,794 | 332,000 | 10,750,000 | 7,500,000 | 22,036,794 |
| 1907 | 2,891,743 | 275,000 | 9,183,000 | 7,000,000 | 19,349,743 |
| 1908 | 3,448,318 | 401,500 | 10,323,000 | 5,120,000 | 19,292,818 |
| 1909 | 4,264,716 | 265,000 | 11,580,000 | 4,302,000 | 20,411,716 |
| 1910 | 4,182,730 | 351,630 | 8,062,389 | 3,530,000 | 16,126,749 |
| 1911 | 4,265,573 | 313,538 | 9,139,145 | 3,135,000 | 16,853,256 |
| Total | 56,477,874 | 4,673,668 | 74,118,534 | 60,349,700 | 195,619,776 |

In 1911 about one-quarter of the gold production came from lode mines and three-quarters from placer mines. This maintains the same ratio between lode and placer output that existed in 1910. It is to be expected that before long the percentage of lode production will increase, which will result in a greater stability in the annual gold output than is possible where the maintenance of the production depends on the exploitation of rich gravel deposits. The increased use of dredges will also bring about less fluctuation in the annual placer gold production. In the following table the production of precious metals has been distributed as to sources:

*Sources of gold, silver, and copper in Alaska, 1911, by kinds of ores.*

| | Tonnage. | Gold. | | Silver. | | Copper. | |
|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. | Quantity. | Value |
| | *Short tons.* | *Fine ounces.* | | *Fine ounces.* | | *Pounds.* | |
| Siliceous ores | 1,594,404 | 204,465.99 | $4,226,687 | 29,829 | $15,810 | | |
| Copper ores | 68,975 | 4,187.77 | 86,569 | 320,114 | 169,660 | 27,267,878 | $3,408,485 |
| Placers | | 606,622.50 | 12,540,000 | 110,288 | 58,452 | | |
| Total | 1,663,379 | 815,276.26 | 16,853,256 | 460,231 | 243,922 | 27,267,878 | 3,408,485 |

The total gold production from the auriferous lode mines of Alaska which have been productive since 1882 is estimated to be 2,554,631 fine ounces, valued at $52,808,901. These mines have also produced 1,029,743 fine ounces of silver, with a commercial value of $626,901.

Including several properties in the new lode districts, which made only small outputs, there were 18 gold-lode mines (which were operated for the whole or a part of the year) in Alaska in 1911, 6 more than in 1910. Work was also done on many gold prospects, a few of which produced some gold as an incident to the development work. Of the producing auriferous mines, 8 were in southeastern Alaska, 3 at Willow Creek, 3 at Fairbanks, 2 on Kenai Peninsula, 1 on Prince William Sound, and 1 in southwestern Alaska.

There were 8 productive copper mines in 1911, as compared with 7 in 1910. Of these, 3 were in the Ketchikan district, 4 on Prince William Sound, and 1 in the Kotsina-Chitina district.

The tonnage of all the lode mines in 1911 was 1,633,379 short tons as against 1,526,625 short tons in 1910. Of the increased tonnage, 107,144 is to be credited to the gold mines and 29,610 to the copper mines. Of siliceous ores 1,594,404 short tons were mined, of which 1,473,983 short tons were from the three mines of the Treadwell group. The average gold and silver extraction from all the siliceous ores was valued at $2.66 per ton. For the 120,421 short tons other than from the Treadwell group the gold and silver recovery was a little more than 14 per cent of the total value of the siliceous ores of Alaska. The total tonnage of copper ore was 68,975 short tons, which yielded an average value of $3.71 per ton in gold and silver, and 19.76 per cent of copper. The large average copper percentage is due to the very high-grade ores shipped from the Bonanza-Kennicott mine.

It is estimated that a total of 740 placer mines were operated in 1911, as compared with 650 in 1910. In 1911 about 5,790,000 cubic yards of gravel were excavated with an average recovery per cubic yard of $2.17, as against 3,800,000 cubic yards excavated in 1910, with an average recovery of $3.20 per yard. Twenty-seven gold dredges were operated in 1911 and 18 in 1910. It is estimated that these dredges in 1911 handled between 2,100,000 and 3,000,000 cubic yards of material and recovered gold to the value of about $1,500,000. The gold output from the dredges in 1910 had a value of about $800,000.

## REVIEW BY DISTRICTS.

### PACIFIC COASTAL BELT.

#### SOUTHEASTERN ALASKA.

The auriferous lode mines of southeastern Alaska are estimated to have produced gold to a value of $3,904,217 in 1911, as compared with an output of $3,839,626 in 1910. In this region there were 8 gold lode mines and 3 copper mines operated in 1911, and 9 gold mines and 3 copper mines in 1910. Four placer mines were operated in southeastern Alaska in 1911.

*Juneau precinct.*—The Treadwell group of mines, on Douglas Island, continued in 1911 to be the source of most of the gold output of southeastern Alaska and, in fact, of the lode production of the entire Territory. Among the important developments on this property was the addition of a new central hoisting plant and crusher, which was completed in 1911. At the Treadwell mine the ore was taken from the 1,450-foot and 1,600-foot levels, and considerable dead work was done on the 1,750-foot level. The 1,210-foot and 1,320-foot levels furnished most of the ore at the Alaska-Mexican mine, and the mine workings were extended on the 1,460-foot and, to a less extent, on the 1,570-foot levels. The ore from the Ready Bullion came chiefly from the 1,650-foot and 1,800-foot levels, and the dead work was chiefly on the 1,100-foot and 1,350-foot levels. In the 700-foot claim productive mining was chiefly on the 1,210-foot and 1,320-foot levels, and dead work on the 1,600-foot level and in the shaft. Twenty stamps were added to the mill of the 700-foot claim.

Besides the Treadwell group, only two other properties on Douglas Island received any attention in 1911. A new company is reported to have taken hold of the Bears Nest property and done some prospecting. Operations at the Alaska Treasure, on Nevada Creek, which

had been temporarily suspended about the close of 1910, were resumed in 1911. The main crosscut was extended from 3,100 to 3,400 feet, giving a depth of 750 feet below the upper, or Hudson, crosscut. Some ore bodies are said to have been found. The work in hand consists in driving from the face of the main crosscut in a northerly direction in the expectation of intersection of the ore body exposed in the Hudson, or upper, level.

As in previous years, the Perseverance mine, in the Silverbow Basin of the mainland portion of the Juneau gold belt, was operated during the open season, which in 1911 amounted to 153 days. The mill at the Alaska Juneau mine was also operated for a part of the year, but chiefly for sampling purposes. Plans to develop this property on a large scale, which have been under consideration for some years, took definite form in 1911. About 100 feet of an adit tunnel was completed, which will undercut the ore body of the Alaska Juneau at a depth of about 600 feet. The portal of this tunnel is on Snowslide Gulch, a tributary of Gold Creek. A tram road has been graded from the portal of the tunnel, which is destined to bring the ore to a mill at tidewater near Juneau. The tunnel, which follows a fault line, will have a length of about 6,000 feet. A ditch to bring water from Gold Creek has also been constructed. The California & Nevada Copper Co. continued work on its tunnel on the Ebner property.

Little information has been obtained regarding the mines north of Juneau. It is known that systematic development has been continued on the Kensington property at Berners Bay, which will soon be placed on a productive basis. Some plans were also made to reopen the Jualin mine, located in the same district. In the aggregate considerable work was done also on various other properties located between Juneau and Berners Bay. The mill at the Eagle River mine was operated only a short time during the year, and most of the work at this place was directed to further underground exploration. One hydraulic placer mine was operated in the Silverbow Basin in 1911.

*Porcupine district.*—Two hydraulic mines were worked in the Porcupine district, one on Porcupine and one on Cahoon Creek. Considerable work was also done on Nugget Creek, where preparations are being made to put in a hydraulic plant.

*Sitka district.*—The Chichagoff and Golden Gate gold mines, located on Chichagoff Island, were both operated in 1911. Each is equipped with a 10-stamp mill.

*Ketchikan district.*—The copper deposits are still by far the most important of the mineral resources of the Ketchikan district, but in 1911 more attention was given to the auriferous lodes than in 1910. Three copper mines were operated in 1911, as compared with four in 1910. The Mount Andrew and Jumbo mines were on a productive basis, as in previous years. At the Jumbo a crosscut is being driven to the main haulage adit to bring cars direct to bunkers. Ore shipments were also continued from the It mine, where operations which had been temporarily suspended were resumed in April. A 1,400-foot tunnel, destined to undercut the ore body at a depth of 500 feet, was driven at the It mine and is said to have intersected an ore body. At the Joker mine only assessment work was done in 1911. Some small shipments of ore were made from the Rush & Brown mine. Developments have also been pushed at the Redwing mine, which has been

equipped with a compressor and is to be put on a productive basis in 1912. The main tunnel on the Victory property at Seal Bay, Gravina Island, has been driven a distance of 1,900 feet, and other underground developments have been made. New discoveries of copper ore are also reported on the Copper Center and Gopher (Hyda) properties. The Northland Development Co., whose property is near Klawak, continued sinking a shaft and is reported to have blocked out some ore.

The Lon de Van Mining & Milling Co. continued to drive a crosscut tunnel on Georges Inlet, an indentation of Revillagigedo Island, which is intended to cut an ore body outcropping 900 feet above sea level. At the close of the year the tunnel is said to have been driven about 2,000 feet and to have penetrated an ore body carrying chiefly a silver-bearing galena and containing some gold values. Some further developments were also made on the auriferous lode located on the Gervis property near Hollis. Only assessment work was done at the Moonshine and Old Glory mines, both in the Ketchikan district. Some developments were made by a company which had a bond on the Goldstream group of claims, located on Gravina Island.

The advances made in the Portland Canal region of British Columbia stimulated prospecting on the Alaska side of the boundary and within the Ketchikan district. Some encouraging results are reported in this field.

*Beach mining.*—As in previous years, from 25 to 40 men were engaged in mining beach placers at various places between Lituya Bay and Unga Island. Yakataga is the most important center of this industry. It is estimated that from 15 to 20 men were engaged in beach mining near Yakataga in 1910 and 1911. The hydraulic plant erected on White River about 8 miles east of Yakataga some years ago was again operated in 1911. There was some beach mining in 1911 near Anchor Point on Cook Inlet, as there was also at Popof and Unga Islands. It is reported that, late in the summer of 1911, some new beach placers were discovered near Uyak on Kodiak Island.

### PRINCE WILLIAM SOUND.

The mining industry of Prince William Sound, as to both development and production, had in 1911 the most prosperous season of its history. It is estimated that the value of the total mineral production, including copper, gold, and silver, exceeded $1,000,000. One gold mine, the Cliff, near Valdez, and three copper mines, the Beatson-Bonanza, the Ellamar, and the Threeman, were on a productive basis, and several other copper properties were developed to an extent sufficient to give assurance of an output of metal at an early date. Besides this, much development work was done on at least a score of auriferous quartz veins, some of which will probably make a gold production in 1912. A customs mill was established at Valdez, to which ore was brought from several quartz claims of the district.

The mill at the Cliff mine on Port Valdez, was burned in July, but was replaced before the end of the year. Meanwhile the ore was shipped to Tacoma. The mine workings were carried to a depth of 100 feet below sea level during the year. A score of other properties were developed in the region, and a few of them produced some ore which was treated at the Valdez customs mill. Next to the work

done at the Cliff mine, the most extensive operations were by the Valdez Mining Co. on a property located about 8 miles north of the town. Here several hundred feet of tunnel were driven, and an ore body was developed 110 feet below the outcrop.

The ore shipped from the Ellamar copper mine was taken from the upper level, which had been made available by a coffer dam, completed in 1910. Work was continued on the property of the Hemple Mining Co., on Landlocked Bay, where a total of 2,000 feet of tunnel has been driven. The Threeman Mining Co. completed the building of wharf and bunkers, and these put the property on a productive basis. The first shipment of ore was made in November. The mine is developed on five levels, with an aggregate of 4,000 feet of underground work. Some work was also done by this company on the Mason and Gleason claims, located near Irish Cove. Developments were continued on the property of the Standard Copper Mines Co., located near Landlocked Bay. In all 50 feet of shaft have been sunk and 1,100 feet of tunnel have been driven on this property. The Fidalgo-Alaska Copper Co. completed its aerial tram, wharf, and 1,000-ton bunkers, besides continuing underground developments. Some ore was delivered at the bunkers before the close of the year, although no shipments were made.

As in previous years, the Beatson-Bonanza mine, on Latouche Island, was the largest shipper of copper ore on the sound. On this property development both in surface equipment and in underground workings made substantial progress during 1911. Considerable prospecting was also done on the adjacent Barrack-Girdwood property, and a crew of men were also employed on the claims of the Reynolds Alaska Development Co., near Horseshoe Bay. The Seattle-Alaska Mining Co. completed the erection of a concentrating plant on its propeerty, located near Montgomery Bay. It is reported that at this place a mineralized shear zone carrying copper and high values has been crosscut at a depth of 400 feet.

Development work has been continued on the property of the Knight Island Copper Co., located about 3,500 feet from tidewater at Drier Bay. The mine is equipped with an air compressor and drills run by water pressure. There are 2 tunnels on the property aggregating 450 feet in length and a shaft 60 feet deep. Work on the Pandora claim in 1911 consisted of a winze sunk some 20 feet, near the face of the adit, which is 140 feet long. There were also developments on copper prospects in different parts of the sound.

### KENAI PENINSULA.

Auriferous lode development was active in the Kenai Peninsula during 1911. A 5-stamp mill was put up on the property of the Kenai-Alaska Gold Co., and a 3-stamp mill on the property of the California-Alaska Mining Co. The smaller mill appears to have been utilized only in prospecting, but the larger one was operated for a part of the summer months. Considerable development work was also accomplished on a number of other properties, notably on some located near Seward, at the head of Kenai Lake, and on Crow Creek.

No notable advances were made in the mining of Kenai Peninsula placers. The discovery in 1910 of gold-bearing gravels near the head of Kenai River was followed by the staking of practically the entire length of the river as possible dredging ground. In 1911 a

small dredge began work below Cooper Creek, but it appears to have given unsatisfactory results. The building of a large dredge started during the summer had not been completed at the end of the season. Hydraulic plants were in operation on Crow, Resurrection, Canyon, Gulch, Quartz, Cooper, Mills, and Sixmile Creeks. On Cooper Creek a Ruble elevator was in use.

### SOUTHWESTERN ALASKA

No new discoveries are reported in the Iliamna region, and but little prospecting was done in this field. The Apollo mine, on Unga Island, was, as in previous years, the only productive property in southwestern Alaska. Ten stamps were operated in this property during the summer months.

#### COPPER RIVER REGION.

*Kotsina-Chitina district.*—The improved transportation facilities furnished by the Copper River Railway led to more development work on copper properties in the Kotsina-Chitina region than in any previous year, but details in regard to this work are lacking at this writing. The shipping of ore from the Bonanza mine began in April and continued throughout the rest of the year. A plant was built at the end of the railway for concentrating the lower-grade ores of the talus slope at the Bonanza mine. Much development work was done on the Mother Lode property, which is on the McCarty Creek side of the Bonanza divide, and a large body of high-grade ore is said to have been blocked out. Systematic development work was also undertaken at the Nikolai property, also in the McCarty Creek basin. At Copper Mountain, near the western end of the belt, the ore was crosscut at a depth of about 800 feet below the outcrop. Developments were also continued on Nugget and Elliot creeks as well as in other parts of the district.

*Nizina and Chistochina districts.*—Two hydraulic plants and several smaller operations were employed in placer mining in the Nizina district. About 20 claims were worked in the Chisna district. A hydraulic plant was put in on Chisna River and considerable drilling was done to test placer ground in other parts of this field.

#### SUSITNA BASIN.

*Willow Creek district.*—In the Willow Creek district of the Susitna Valley there were two productive lode gold properties, the Gold Bullion and the Alaska Gold Quartz. Development work was done on three other properties. Considerable prospecting was also done on other claims. Five 1,000-pound stamps were added to the 2-stamp mill in use at the Gold Bullion mine in 1910. A 3-stamp mill with 500-pound stamps driven by a Pelton water wheel was erected on the property of the Alaska Gold Quartz Mining Co. Aerial tramways were constructed on both these properties.

*Yentna district.*—Most of the gold output of the Yentna placer district came from Cache and Peters creeks and their tributaries. The largest production in 1911 as in 1910 was from Nugget and Willow creeks, although the discovery of an old channel in the bench of Dollar Creek placed that stream among the important producers of

the district and gave promise of a still larger output for 1912. Mining operations were continued in the basins of Twin and Mill creeks. Coarse gold was discovered in 1911 on Lewis Creek, a tributary of Theodore River, on the west side of the Susitna Mountain.

*Valdez Creek district.*—Placer mining continued in a small way on Valdez Creek during 1911. The most important event of the year was the consolidation of a group of claims, with a purpose of their development as a single unit. Preliminary steps were taken looking to the addition of a large hydraulic plant.

YUKON BASIN.

The value in 1911 of the placer production of the Yukon basin, including the Innoko-Iditarod region, is estimated at $9,050,000, as compared with $8,020,000 in 1910. This gain is due largely to the increased production from the Innoko-Iditarod region, but the output from the Hot Springs, Birch Creek, and Fortymile regions was also greater than in 1910.

*Fairbanks district.*—Although there was some lode prospecting in other parts of the Yukon-Tanana region, the only notable advances in hard-rock mining were those made in the Fairbanks district. It is reported that during 1911 development work was done on about 25 to 30 properties beyond that required annually for assessment work. Of these about 8 or 10 produced gold to the value of $1,000 or more. Most of the ore produced was crushed at the two customs mills located at Chena and Fairbanks. In addition to this, some ore was treated at the three mills which were erected on different properties during the latter part of the year. The equipment of these 5 mills aggregated 26 stamps. It is estimated that about 875 tons of ore were treated during the year in the district, yielding about $64,000 in gold. Probably about 8 or 10 per cent of this represents the value of the concentrates, the balance being free gold. The high value per ton is accounted for by the fact that much of the ore sent to the customs mills is hand sorted and does not represent an average of the ore mined. The total amount of hard-rock underground work is estimated at the close of 1911 to have been in the neighborhood of 6,000 feet, compared with 3,000 feet at the close of 1910. At the Free Gold Mine (Roads & Hall) a total of about 1,200 feet of underground work had been completed at the close of 1911 and in midsummer a 5-stamp mill (1,000-pound stamps) was erected. In addition to the ore treated at the mine, considerable shipments were also made to the Chena customs mill.

The Tanana Quartz Mining Co. sunk a 50-foot winze from main tunnel and drifting was begun on the vein at this depth. Some shipments of ore were made to one of the customs mills, and in October a 5-stamp mill was erected on the property.

On the Newsboy property, a shaft was sunk to a depth of about 200 feet, and the mine was opened up on two levels. At the close of the year the sinking of the shaft to the 315-foot level was being pushed, as was the drifting on the 215-foot level. Ore was shipped to the customs mill from the 65-foot and 115-foot levels, where stoping was done. In October a 5-stamp mill was installed.

Fairbanks continues to lead all the other Yukon camps in placer gold mining, though the value of the output of 1911 was only $4,500,000 compared with $6,100,000 in 1910. The most important advance of the year was the completion of a dredge on upper Fairbanks Creek, the first dredge in this district, though plans have been made for others. Mining operations were somewhat hampered in June and July by the lack of men, due to the stampede to Ruby Creek. The water supply was as usual inadequate, and this condition was probably of more serious consequence than in 1910. Goldstream, Engineer, lower Cleary, and Fairbanks creeks were the principal producers. It is estimated that about 75 claims were worked in the winter and about 124 claims in the summer of 1911.

*Hot Springs district.*—The value of the gold output of the Hot Springs district in 1911 is estimated at $785,000. Most of this gold was taken from the placers of the Patterson Creek basin, and chiefly from Sullivan, Cache, Quartz, and American creeks.

*Rampart district.*—Placer mining has continued to decrease in the Rampart district for a number of years. The value of the gold output of 1911 was about $32,000, which was taken from the placers of Hunter, Little Minook, and Quail creeks.

*Fortymile and Seventymile districts.*—Two dredges were successfully operated in the Fortymile region. One on Walkers Fork worked the entire open season; the other, situated on the South Fork, 3 miles below Franklin, began operations about the end of June. The latter had been moved from Walkers Fork to its present location during the winter. The smaller operators were hampered during the summer by lack of water, and the Ruby Creek excitement carried many men away from the district. A large ditch was under construction at Dome Creek. It is estimated that in the Fortymile district proper 35 claims were worked during the winter and 15 or 20 claims in the summer.

Mining was continued in a small way in the region tributary to Eagle, which includes the American, Mission, and Seventymile basins. It is estimated that winter work was done on 20 claims and summer mining on 19 claims. The value of gold output from the Fortymile and Seventymile districts in 1911 was $212,000, about the same as that of 1910.

*Birch Creek district.*—Three hydraulic plants, all on Mastodon Creek, were installed in the Birch Creek district during the summer of 1911. All these suffered for lack of water and operated only a part of the season. In addition to this, the two existing hydraulic plants on Eagle and Mammoth creeks were operated so far as water permitted. The principal producing creeks were Mastodon, Deadwood, Mammoth, Eagle, Independence, and Switch. It is estimated that in the Circle district 29 claims were worked during the winter and 37 claims during the summer of 1911. In the Beaver Creek region no important advances were made. The best prospects in this basin are said to be those on Ophir Creek.

*Bonnifield and Kantishna districts.*—There appear to have been no important developments in the Bonnifield and Kantishna districts in 1911. The total value of the gold output from this region, lying south of Tanana River, was less than $50,000. The productive

streams included Moose Creek and tributaries of the Tatlanika, Totatlanika, and Wood rivers. About 20 men were engaged in mining in the Kantishna district, chiefly on Glenn, Bearpaw, Eureka, and Moose creeks, and McKinley Fork.

*Chandalar and Koyukuk districts.*—A little productive placer mining was done on Big Creek in the Chandalar district. The Chandalar Mining Co. continued to drive its adit tunnel on an auriferous quartz vein.

It is estimated that gold to the value of $140,000 was produced from the Koyukuk district in 1911, compared with an output of $160,000 in 1910. Among the important events of the year was the finding of valuable placers in the benches of Sheep Creek and the extension of the pay streak on Nolan Creek. Some new discoveries of gold-bearing gravel are also reported in the basin of Hammond River. In 1910 auriferous gravels were found in the basin of Indian Creek, which is a tributary of the Koyukuk from the east about 4 miles above Waite Island, 374 miles from the mouth of the latter river. These discoveries were made on Snyder and Felix creeks, which are tributaries to the headwaters of Indian Creek. Placer gold prospects are also said to have been found on Dome Creek, which flows north, being a part of the Kanuti drainage basin. Several claims were worked in this district in 1911, the value of the output being estimated at $14,000.

*Ruby Creek district.*—The Ruby Creek district, where gold was first found in 1907, attracted renewed interest in 1911. Considerable excitement was caused among the Yukon miners by the reported discoveries during the summer of rich placers in some creeks located in this general region and 20 to 30 miles from the Yukon. As a consequence, there was a general movement toward the new find from the Yukon camps. These discoveries of placer gold were made in the headwater region of Solatna River, which heads on the south side of the Ruby Creek divide and flows northward to join the Nowitna, a southerly tributary of the Yukon. The creeks reported to carry gold are Glenn, Birch, Flint, and Long creeks and some of their tributaries.

*Innoko-Iditarod region.*—Placer mining was very successful in the Innoko-Iditarod region during 1911, the value of the gold output being estimated at about $3,000,000, as compared with a value of $825,000 for the output of 1910. The open season was unusually long, mining continuing until November.

Most of the placers are shallow and are mined by open-cut methods. Consequently there is little winter work in the district, where probably not over 15 or 20 mines are operated. Most of these are in the Innoko part of the field.

Flat Creek, a tributary of Otter, was in 1911 the largest producer of gold in the entire region. Mining was also done on Otter and on several of its tributaries besides Flat, including Glenn, Gulch, and Black creeks. As in previous years the mines of the Willow Creek Basin made a considerable output. Mining was also done on the divide between Flat Creek and Happy Gulch, flowing into Willow Creek, as well as on Gold Creek, also tributary to Willow. Chicken Creek is also reported to have been the scene of productive mining in 1911.

There has also been much prospecting and considerable mining on the Kuskokwim side of the divide. Of the tributaries of the Tocotna,

Moore and Fourth-of-July creeks were the scene of considerable mining. There was also some mining on Donalin, Julien, Beaver, Marietta, and Crooked creeks, and on Snow Gulch.

It is estimated that in the Innoko district about 13 claims were worked during the winter, and about 25 claims during the summer. The largest output of gold came from the mines of Yankee, Ophir, and Gaines creeks, but mining was also done on Little Spruce and other streams. A ditch was completed which will furnish water for mining the benches on Spruce Creek.

### KUSKOKWIM REGION.

The reports of prospectors indicate that placer gold has been found at various places in a belt which stretches southwest from the Iditarod district to Goodnews Bay, on Bering Sea. Placer gold has been found on "Holokuk River." This is probably Chulitna River, which flows into the Kuskokwim from the south about 100 miles above Georgetown. Another discovery is reported on "Anniok River," and on its tributaries, Cripple and Salmon creeks. There was a little placer mining on Toluksak River, which flows into the lower Kuskokwim from the east about 100 miles above Bethel. It is reported that about $15,000 was taken from these placers in 1911. Rigugalik River joins the Kuskokwim about 30 miles below the mouth of the Toluksak. Fine gold has been found on this stream, and in 1911 some tests were made with a small hydraulic plant which is reported to have yielded encouraging results. It is reported that some gold, silver, and antimony bearing quartz veins have been found in the basin of Rigugalik River. Gold prospects are said to have been found on the Kwisluk and the Eek and other rivers which flow into the Kuskokwim from the east below the mouth of the Rigugalik.

In 1910 placer gold was discovered in streams tributary to Goodnews Bay, a small indentation of the east shore of Kuskokwim Bay. In 1911 workable placers were found in this district, on Butte Creek, about 25 miles from tidewater. Here mining was done on four claims, with a total output of about $12,000.

*Seward Peninsula.*—The gold production of Seward Peninsula for 1911 is estimated to have a value of $3,100,000; that of 1910 had a value of $3,530,000. In view of the fact that the winter operations of 1910 produced almost a million dollars' worth of gold, and those of 1911 probably had a value of less than $200,000, the output of the summer of 1911 was far greater than that of the preceding year. As in 1910, the important feature of the mining industry was the building and operating of dredges. Including two small machines 24 gold dredges in all were operated in the Seward Peninsula. Of these, 3 were built in 1911. Three other dredges were in part completed. These 27 dredges[1] are distributed as follows: Nine in the Nome district, 8 in the Solomon River district, 8 in the Council district, 1 on Cripple River, and 1 in the Kougarok district. Although dredge mining was the most important industry, other phases of mining were not neglected. A number of hydraulic plants were operated in the Kougarok, Nome, and Fairhaven precincts, and there

[1] This does not include a dredge in the York district completed and operated in 1911 for recovering stream tin.

were in the aggregate many small plants in operation. An important feature of the year's mining was the fact that a large number of the dredges continued operations until the first week in November.

A customs mill was erected at Nome late in the summer of 1911, and considerable ore was tested there during the last month of the year. This has stimulated development work on a number of lode prospects in the Seward Peninsula.

*Kobuk district.*—During 1911 a little mining was done in both the Shungnak and Squirrel River districts of the Kobuk Valley, and gold was recovered to the value of about $35,000. Klery Creek appears to be the only stream in the Squirrel River region on which productive mining has been done, though alluvial gold has been found on other streams. At least two placer mines were worked in the Shungnak region, but high water seriously hampered operations. A nugget valued at about $600 was found on Dahl Creek in 1911.

## ARIZONA.

By V. C. Heikes.

### PRODUCTION.

There were 397 producing mines in Arizona, 42 of which were placers, in 1911, and the output of gold, silver, copper, lead, and zinc was valued at $44,157,223. Compared with the figures for 1910, 24 more producing mines were reported, and the total value increased $1,425,704.

The metal-mining industry of the State was characterized by an increase in ore mined, from 3,914,969 tons in 1910 to 4,567,139 tons in 1911, resulting in the increased production of gold, silver, copper, and lead. The large mining operations at Ray, in Pinal County, and at Miami, in Gila County, were material factors in increasing the State output of copper from 297,491,151 pounds in 1910 to 306,141,538 pounds in 1911, and in value from $37,781,376 to $38,267,692. The gold production was second in value, increasing from $3,149,366 in 1910 to $3,430,503 in 1911. The concentration of copper ores has been limited chiefly to Globe, and Clifton and Morenci, in Gila and Greenlee counties, respectively, until 1911, when two of the largest mills were completed, one at Miami and the other (the Ray mill) at Hayden, both in Gila County. These were started and doubled the milling facilities of the State, causing an increase in ore concentrated from 1,426,443 tons, with a recovery of 254,022 tons of concentrate valued at $7,818,321, in 1910, to 2,624,037 tons, with a saving of 314,761 tons of concentrate, valued at $12,623,645, in 1911. Smelting establishments received from the mines a decreased output of crude ore, from 2,284,726 tons, valued at $33,115,707, in 1910, to 1,727,451 tons, valued at $29,393,766, in 1911. Decreases in output of ore of shipping grade were made principally in Yavapai, Pima, and Cochise counties. Amalgamation and cyanide mills treated 169,723 tons of ore and 12,428 tons of tailings, valued at $1,940,732 for the gold and silver bullion and cyanide product. Iron and lead concentrates were saved at a number of mills. Compared with the output of the same products in 1910, the quantity of material treated was 14,394 tons less and the total value $168,406 greater. A further

decline in the value of the placer output is recorded. Only $23,641 in gold was credited to placers in 1911, against $25,990 in 1910 and $28,648 in 1909.

The statement of production for 1910 and 1911, showing increases and decreases, and valued at each year's average commercial price, is as follows:

*Mine production of gold, silver, copper, lead, and zinc in Arizona in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 132,350.58 | $3,149,366 | 165,950.58 | $3,430,503 | +13,600.00 | +$281,137 |
| Silver.....do.... | 2,566,528 | 1,385,925 | 3,276,571 | 1,736,583 | + 710,043 | + 350,658 |
| Copper.....pounds.. | 297,491,151 | 37,781,376 | 306,141,538 | 38,267,692 | +8,650,387 | + 486,316 |
| Lead.....do.... | 2,696,998 | 118,668 | 10,274,552 | 462,355 | +7,577,554 | + 343,687 |
| Zinc.....do.... | 5,484,899 | 296,184 | 4,562,984 | 260,090 | − 921,915 | − 36,094 |
| Total..... | ..... | 42,731,519 | ..... | 44,157,223 | ..... | +1,425,704 |

Statistics showing the total metallic output since 1904 are given in the following table:

*Quantity of ore sold or treated in Arizona in 1904–1911, and content in gold, silver, copper, lead, and zinc.*

| Year. | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1904..... | 2,305,938 | 168,274.00 | 2,314,940 | 199,481,044 | 1,779,967 | ..... | $29,816,840 |
| 1905..... | 2,678,059 | 135,412.00 | 2,605,712 | 228,418,679 | 4,940,910 | 140,000 | 40,246,861 |
| 1906..... | 3,585,089 | 143,416.55 | 3,026,438 | 266,831,864 | 5,638,735 | ..... | 56,812,355 |
| 1907..... | 3,567,133 | 126,612.52 | 2,511,897 | 254,879,489 | 4,660,684 | 228,490 | 55,511,560 |
| 1908..... | 3,696,938 | 117,646.89 | 2,808,450 | 285,858,133 | 3,008,583 | 678,446 | 41,811,975 |
| 1909..... | 4,029,955 | 132,426.56 | 2,601,161 | 303,899,461 | 3,098,083 | 5,977,237 | 44,053,023 |
| 1910..... | 3,914,969 | 152,350.58 | 2,566,528 | 297,491,151 | 2,696,998 | 5,484,899 | 42,731,519 |
| 1911..... | 4,567,139 | 165,950.58 | 3,276,571 | 306,141,538 | 10,274,552 | 4,562,984 | 44,157,223 |

## ORE PRODUCTION IN 1911.

From Arizona mines 4,567,139 tons of ore were produced in 1911, an increase of 652,170 tons over the output of 1910, but the average value per ton decreased from $10.91 to $9.66. This was chiefly owing to the large increase in the mining of low-grade copper ores at Ray and Miami, and a proportionate further decrease may be expected as the tonnage of the low-grade ores increases. The low-grade copper ores carry very little value in gold and silver, so the gold and silver average per ton was not materially affected, decreasing from $1.15 in 1910 to $1.13 in 1911. The increase of ore production was mainly in copper ores, lead ores, zinc ore, and lead-zinc ore. The output of copper ores increased from 3,644,495 tons in 1910 to 4,274,209 tons in 1911. Included in this kind of ore were the so-called low-grade schists and porphyry ores, aggregating 1,127,156 tons. The production of lead ores increased from 6,240 tons in 1910 to 22,039 tons in 1911; of zinc ore from 7,650 tons in 1910 to 16,106 tons in 1911;

and of lead-zinc ores 10,756 tons were produced in 1911. The average yield per ton of gold and silver in siliceous ore in 1911 was $9.72, against $8.65 in 1910; in copper ore, 51 cents, against 59 cents in 1910; in lead ore, $21.52, against $15.60 in 1910; in zinc ore, $2.75, against $5.90 in 1910; in copper-lead ore, $23.05, against $19.23 in 1910; and in lead-zinc ore the precious metal content was valued at $5.34 per ton in 1911. The total tonnage produced, based on the quantity of crude ore mined and sold or treated in Arizona in 1911, is shown in the following table:

*Output of ore and production of metals in Arizona in 1911, by kinds of ore.*

| Source of production. | Number of producers. | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Placers | 42 | ..... | 1,143.63 | 154 | ..... | ..... | ..... |
| Siliceous ore | 170 | 243,900 | 104,011.72 | 414,981 | 730,140 | 111,580 | 8,913 |
| Copper ore | 109 | 4,274,209 | 51,377.93 | 2,136,121 | 305,110,593 | 8,037 | ..... |
| Lead ore | 78 | 22,039 | 6,651.95 | 635,363 | 269,197 | 7,618,941 | ..... |
| Zinc ore | 4 | 16,106 | 1,119.01 | 40,067 | 1,676 | 211,046 | 3,593,974 |
| Copper-lead ore | 7 | 129 | 13.01 | 5,102 | 10,603 | 101,597 | ..... |
| Lead-zinc ore | 4 | 10,756 | 1,633.33 | 44,783 | 19,329 | 2,223,351 | 960,097 |
| Total | ..... | 4,567,139 | 165,950.58 | 3,276,571 | 306,141,538 | 10,274,552 | 4,562,984 |

*Subdivision of tonnage of ore sold or treated in Arizona in 1911, by counties, in short tons.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|
| Cochise | 43,289 | 1,104,406 | 19,467 | 37 | 38 | ..... | 1,167,237 |
| Coconino | 374 | 16 | ..... | ..... | ..... | ..... | 390 |
| Gila | 399 | 734,993 | 40 | ..... | ..... | ..... | 735,432 |
| Graham | ..... | ..... | 33 | ..... | ..... | ..... | 33 |
| Greenlee | 4,983 | 1,545,998 | 239 | ..... | ..... | ..... | 1,551,220 |
| Maricopa | 19,252 | 4 | ..... | ..... | ..... | ..... | 19,256 |
| Mohave | 112,541 | 344 | 781 | 15,980 | ..... | 10,756 | 140,402 |
| Pima | 37 | 8,121 | 50 | ..... | 2 | ..... | 8,210 |
| Pinal | 4,387 | 681,655 | 103 | ..... | 67 | ..... | 686,212 |
| Santa Cruz | 353 | 458 | 218 | 27 | 22 | ..... | 1,078 |
| Yavapai | 51,084 | 193,300 | 719 | 62 | ..... | ..... | 245,165 |
| Yuma | 7,201 | 4,914 | 389 | ..... | ..... | ..... | 12,504 |
| Total | [a] 243,900 | 4,274,209 | 22,039 | 16,106 | 129 | 10,756 | 4,567,139 |
| Value per ton in gold and silver | $9.72 | $0.51 | $21.52 | $2.75 | $23.05 | $5.34 | $1.13 |

[a] Includes 187,490 tons of gold and gold-silver ores and 56,410 tons of silver ores.

## GOLD.

About three-fifths of the gold output in Arizona in 1911 was from dry or siliceous ores, mined mainly from veins in rhyolite and andesitic lavas. The most prominent examples are the Gold Road and Tom Reed deposits, situated in Mohave County; the King of Arizona and North Star, in Yuma County; the Mammoth district, Pinal County, and the well-known Commonwealth mine in the Pearce district, Cochise County. The silver content in the Commonwealth mine exceeds the gold. New ore bodies of importance were reported to have been opened up in the extension of the vein of the Commonwealth mine.

Mines in Mohave, Cochise, Yavapai, and Yuma counties together yielded nearly 95 per cent of the total quantity of gold, which, in 1911, aggregated 165,950.58 ounces, valued at $3,430,503, as against 152,350.58 ounces, valued at $3,149,366, in 1910. The production of gold from copper ores mined chiefly in the Warren district of Cochise County and from the siliceous ores of the Tom Reed and Gold Road mines in Mohave County was important. There were large decreases in the gold putput of Yavapai, Yuma, and Greenlee counties. The amalgamation process yielded $234,555 in gold, and the cyanidation process, from ore and old tailings, $1,680,121 in gold. Nearly all of the zinc precipitates were reduced to bullion, and but a very small per cent of the product was shipped to refiners. The gold content in crude dry or siliceous ores shipped directly to the smelters averaged $1.63 per ton; in copper ores, 62 cents; in lead ores, $6.45; in zinc ores, $4.31; and in copper-lead ores, $2.08. Dry or siliceous concentrate contained $45.98 per ton in gold; copper concentrate, 11 cents; lead concentrate, $34.93; zinc concentrate, $4.61; copper-lead concentrate, $153.57; and lead-zinc concentrate, $8.07. Placers in Cochise, Gila, Maricopa, Pima, Pinal, Santa Cruz, Yavapai, and Yuma counties yielded $23,641 in gold, as against $25,990 in 1910.

*Source of gold production in Arizona, by kinds of ore, in 1911, by counties, in fine ounces.*

| County. | Placers. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|---|
| Cochise | 5.51 | 1,281.58 | 30,893.16 | 5,740.83 | ..... | 4.00 | ..... | 37,925.08 |
| Gila | 13.26 | 116.40 | 2,300.81 | 3.28 | ..... | ..... | ..... | 2,433.75 |
| Graham | ..... | ..... | ..... | 1.01 | ..... | ..... | ..... | 1.01 |
| Greenlee | ..... | 846.45 | 591.34 | 88.00 | ..... | ..... | ..... | 1,525.79 |
| Maricopa | 46.53 | 4,623.71 | 8.98 | ..... | ..... | ..... | ..... | 4,679.22 |
| Mohave | ..... | 71,694.40 | ..... | 425.46 | 1,115.01 | ..... | 1,633.33 | 74,868.20 |
| Pima | 185.90 | 33.16 | 50.00 | 3.00 | ..... | ..... | ..... | 272.06 |
| Pinal | 56.16 | 656.44 | 10.00 | 31.51 | ..... | 6.01 | ..... | 760.12 |
| Santa Cruz | 29.95 | 60.50 | 7.00 | 5.01 | ..... | 3.00 | ..... | 105.46 |
| Yapavai | 463.48 | 15,310.31 | 17,258.28 | 327.39 | 4.00 | ..... | ..... | 33,363.46 |
| Yuma | 342.84 | 9,388.77 | 258.36 | 26.46 | ..... | ..... | ..... | 10,016.43 |
| Total | 1,143.63 | [a]104,011.72 | 51,377.93 | 6,651.95 | 1,119.01 | 13.01 | 1,633.33 | 165,950.58 |

[a] Includes 101,781.59 ounces contained in gold and gold-silver ores, and 2,230.13 ounces in silver ores.

## SILVER.

The yield of silver was 3,276,571 ounces, valued at $1,736,583, in 1911, as against 2,566,528 ounces, valued at $1,385,925, in 1910. Cochise County in 1911 had the largest yield of silver and made the greatest increase in output. Copper ores mined in Cochise, Yavapai, and Gila counties were the chief source of silver, lead ores following in importance. Dry or siliceous gold and silver ores yielded 84,353 ounces; silver ores, 330,628 ounces; copper ores, 2,136,121 ounces; lead ores, 635,363 ounces; zinc ores, 40,067 ounces; copper-lead ores, 5,102 ounces; and lead-zinc ores, 44,783 ounces. Dry or siliceous concentrates yielded 125,513 ounces; copper concentrates, 184,365 ounces; lead concentrates, 47,563 ounces; zinc concentrates, 29,753 ounces; lead-zinc concentrates, 800 ounces; and copper-lead concentrates, 179 ounces. Crude ore shipped to the smelters contained in dry or siliceous ore 215,892 ounces; copper ore, 1,952,596 ounces; lead ore, 629,239 ounces; zinc ore, 17,044 ounces; and copper-lead ore, 5,102 ounces.

*Source of silver production in Arizona, by kinds of ore, in 1911, by counties, in fine ounces.*

| County. | Placers. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|---|
| Cochise | 2 | 79,301 | 1,296,786 | 569,461 | ..... | 769 | ..... | 1,946,319 |
| Coconino | ..... | 56 | 20 | ..... | ..... | ..... | ..... | 76 |
| Gila | 4 | 4,448 | 242,411 | 950 | ..... | ..... | ..... | 247,813 |
| Graham | ..... | ..... | ..... | 204 | ..... | ..... | ..... | 204 |
| Greenlee | ..... | 65,202 | 38,911 | 316 | ..... | ..... | ..... | 104,429 |
| Maricopa | 5 | 2,718 | 13 | ..... | ..... | ..... | ..... | 2,736 |
| Mohave | ..... | 49,681 | 464 | 10,970 | 38,071 | ..... | 44,783 | 143,969 |
| Pima | 29 | 106 | 12,006 | 1,423 | ..... | 401 | ..... | 13,965 |
| Pinal | 6 | 307 | 24,269 | 1,781 | ..... | 3,551 | ..... | 29,914 |
| Santa Cruz | 5 | 5,408 | 3,403 | 3,401 | 157 | 381 | ..... | 12,755 |
| Yavapai | 44 | 203,357 | 514,380 | 45,124 | 1,839 | ..... | ..... | 764,744 |
| Yuma | 59 | 4,397 | 3,458 | 1,733 | ..... | ..... | ..... | 9,647 |
| Total | 154 | [a] 414,981 | 2,136,121 | 635,363 | 40,067 | 5,102 | 44,783 | 3,276,571 |

[a] Includes 84,353 ounces contained in gold and gold-silver ores, and 330,628 ounces in silver ores.

## COPPER.

Arizona remained the leading copper-producing State and increased the production of that metal from 297,491,151 pounds, valued at $37,781,376, in 1910, to 306,141,538 pounds, valued at $38,267,692, in 1911, an increase of 8,650,387 pounds. Large decreases were made in Pinal and Gila counties. Over two-thirds of the production, or 209,711,491 pounds, came from crude ore shipped to smelters, and 95,200,455 pounds came from concentrates. From old smelter slag treated were recovered 1,215,948 pounds of copper, as against 287,655 pounds in 1910; and from old tailings were recovered 13,644 pounds, against 4,089 pounds in 1910. The output of Cochise County, which includes the Warren district, decreased 13,020,616 pounds. Other large decreases were in Pima and Yavapai counties, but the production from Ray, in Pinal County, and Miami, in Gila County, made the total output far greater than that of 1910. There was little change in production in the Clifton-Morenci region of Greenlee County. The mines in Pinal, Gila, and Greenlee counties produced about 44 per cent of the total output of copper, or 135,964,494 pounds, mainly from concentrates. Copper ores aggregating 4,274,209 tons were mined in largest quantities in Greenlee, Cochise, Gila, Pinal, and Yavapai counties, in order named, and averaged 71.38 pounds per ton, against 3,644,495 tons and an average of 81.42 pounds per ton mined in 1910. Dry or siliceous ores, aggregating 243,900 tons, yielded an average of 2.99 pounds per ton; lead ores, aggregating 22,039 tons, yielded 12.21 pounds per ton; and lead-zinc ores, aggregating 10,756 tons, averaged 1.80 pounds per ton. Copper-lead ores mined in Cochise, Pima, Pinal, and Santa Cruz counties yielded, from 129 tons of ore, an average of 82.19 pounds per ton.

*Source of copper production in Arizona, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|
| Cochise | 595,433 | 131,443,499 | 247,927 | ..... | 3,148 | ..... | 132,290,007 |
| Coconino | 10,042 | 3,552 | ..... | ..... | ..... | ..... | 13,594 |
| Gila | 13,280 | 49,212,400 | 661 | ..... | ..... | ..... | 49,226,341 |
| Graham | ..... | ..... | 365 | ..... | ..... | ..... | 365 |
| Greenlee | 356 | 70,925,974 | ..... | ..... | ..... | ..... | 70,926,330 |
| Maricopa | 46 | 683 | ..... | ..... | ..... | ..... | 729 |
| Mohave | 5,342 | 215,175 | 4,308 | 224 | ..... | 19,329 | 244,378 |
| Pima | 115 | 982,831 | 1,368 | ..... | 423 | ..... | 984,737 |
| Pinal | 14,731 | 15,791,424 | 70 | ..... | 5,598 | ..... | 15,811,823 |
| Santa Cruz | 3,183 | 106,266 | 11,564 | 270 | 1,434 | ..... | 122,717 |
| Yavapai | 85,692 | 36,014,032 | 2,743 | 1,182 | ..... | ..... | 36,103,649 |
| Yuma | 1,920 | 414,757 | 191 | ..... | ..... | ..... | 416,868 |
| Total | [a] 730,140 | 305,110,593 | 269,197 | 1,676 | 10,603 | 19,329 | 306,141,538 |

[a] Includes 76,025 pounds contained in gold and gold-silver ores and 654,115 pounds in silver ores.

## LEAD.

The lead production of Arizona in 1911 was nearly four times as large as that of 1910, increasing from 2,696,998 pounds, valued at $118,668, in 1910, to 10,274,552 pounds, valued at $462,355, in 1911. Increases in lead output were credited chiefly to the Warren district, in Cochise County, with a gain of 4,958,406 pounds in 1911 over the output of 1910. Mohave County mines also increased the lead output from 740,091 pounds in 1910 to 2,591,589 pounds in 1911. Crude ore shipped direct to smelters contained 7,710,622 pounds, and concentrates contained 2,563,930 pounds. Concentrates produced from ore treated at mills after amalgamation of precious metals yielded 382 tons of lead concentrate, containing 70,865 pounds of lead. At mills using concentration methods only, 3,813 tons of lead concentrates were produced, containing 2,361,671 pounds of lead. Copper concentrates yielded no lead. Dry or siliceous concentrates yielded 31,356 pounds of lead. Lead-zinc concentrates aggregating 39 tons, containing 23,472 pounds of lead, were sold to eastern refiners who shipped the residues to western lead works.

*Source of lead production in Arizona, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|
| Cochise | 5,433 | 125 | 6,884,193 | ..... | 17,637 | ..... | 6,907,388 |
| Gila | 49 | ..... | 10,417 | ..... | ..... | ..... | 10,466 |
| Graham | ..... | ..... | 24,982 | ..... | ..... | ..... | 24,982 |
| Greenlee | ..... | ..... | 30,734 | ..... | ..... | ..... | 30,734 |
| Mohave | 7,595 | ..... | 190,599 | 170,044 | ..... | 2,223,351 | 2,591,589 |
| Pima | ..... | 31 | 22,866 | ..... | 609 | ..... | 23,506 |
| Pinal | 1,292 | ..... | 15,975 | ..... | 70,687 | ..... | 87,954 |
| Santa Cruz | 139 | 7,045 | 161,813 | 11,339 | 12,664 | ..... | 193,000 |
| Yavapai | 97,072 | 130 | 191,224 | 29,663 | ..... | ..... | 318,089 |
| Yuma | ..... | 706 | 86,138 | ..... | ..... | ..... | 86,844 |
| Total | [a] 111,580 | 8,037 | 7,618,941 | 211,046 | 101,597 | 2,223,351 | 10,274,552 |

[a] Includes 81,664 pounds contained in gold and gold-silver ores and 29,916 pounds in silver ores.

## ZINC.

Mohave County is credited with 98 per cent of the total output of zinc in Arizona, which amounted to 4,562,984 pounds, valued at $260,090, in 1911. This is 921,915 pounds less in quantity and $36,094 less in value than the output of 1910. Cochise, Santa Cruz, and Yavapai counties made small productions. Milling plants equipped with concentration devices, both wet and dry, recovered the larger part of the zinc output, which was shipped as concentrate to eastern zinc refiners. There were 4,045 tons of zinc concentrate and 39 tons of lead-zinc concentrate produced, both containing 3,093,525 pounds. The output of crude zinc ore, amounting to 2,106 tons, contained 1,469,459 pounds, or 697.74 pounds per ton.

*Source of zinc production in Arizona, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Dry or siliceous ore. | Zinc ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|
| Cochise | ..... | 22,423 | ..... | 22,423 |
| Mohave | ..... | 3,516,455 | 960,097 | 4,476,552 |
| Santa Cruz | ..... | 16,844 | ..... | 16,844 |
| Yavapai | 8,913 | 38,252 | ..... | 47,165 |
| Total | 8,913 | 3,593,974 | 960,097 | 4,562,984 |

## REDUCTION MILLS IN ARIZONA IN 1911.

The following is a list of reduction mills in Arizona in 1911:

*List of reduction mills in Arizona in 1911, by counties.*

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| COCHISE COUNTY. | | | | *Short tons.* |
| Bernoudy [a] | California | Concentration | Crusher, jigs | 50 |
| Middlemarch [a] | Cochise | do | Crusher, 2 Huntington mills, 2 rolls, 2 tables. | 50 |
| Reef [a] | Huachuca | Cyanidation | ..... | 100 |
| Tombstone [a] | Tombstone | Concentration, cyanidation. | 40 stamps | ..... |
| Fluorine [b] | Turquoise | Amalgamation, cyanidation. | 2 stamps, 2 cyanide tanks (15 tons). | 5 |
| COCONINO COUNTY. | | | | |
| Bridal Veil [a] | Cataract Canyon | Concentration | Jigs | 1 |
| GILA COUNTY. | | | | |
| Inspiration [a] | Globe | Concentration | Rolls and tables, experimental mill. | 75 |
| Miami [b] | do | do | Crusher, Chilean, ball, and pebble mills, and tables. | 3,000 |
| Old Dominion [b] | do | do | Crushers, jigs, tables, and rolls. | 500 |
| Yo Tambien [a] | do | do | Tables and jigs | 100 |
| Warrior [a] [c] | do | do | Crushers, rolls, and tables. | 100 |
| 85 Gold Mine [a] | Green Valley | Amalgamation | 2 stamps, plates | ..... |
| Yellow Metal [b] | Lost Gulch | Amalgamation, concentration. | Stamps, plates, and tables. | 30 |

[a] Idle in 1911. [b] Active in 1911. [c] Leaching plant, 400 tons, burned May, 1911.

*List of reduction mills in Arizona in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| GILA COUNTY—contd. | | | | *Short tons.* |
| Saxonia [a] | Tonto | Amalgamation | 5-stamp mill and plates. | 15 |
| Ray [b] | (At Hayden) | Concentration | Crushers, rolls, 24 Chilean mills, 72 Wilfley tables. | 8,000 |
| GRAHAM COUNTY. | | | | |
| San Juan [a] | Lone Star | Concentration | Crushers, tables | 50 |
| GREENLEE COUNTY. | | | | |
| Gold Belt [a] | Copper Mountain | Amalgamation, concentration. | 5 stamps and plates | 15 |
| Detroit Copper [b] | do | Concentration | Crushers, rolls, and tables. | 1,400 |
| Buzzard Shadow e. a. [a] | do | Amalgamation | Stamps, plates | 20 |
| Gold Hill [a] | Gold Hill | Cyanidation | | |
| Arizona Copper [b] | Greenlee | Concentration | Crushers, rolls, jigs, tables. | 1,500 |
| Shannon [b] | do | do | do | 600 |
| MARICOPA COUNTY. | | | | |
| Relief [a] | Agua Fria | Amalgamation | Crusher, Lane mill, rolls, and plates. | 25 |
| Phoenix [a] | Cave Creek | Amalgamation, cyanidation. | 50 stamps | 150 |
| Parker [a] | do | Amalgamation, concentration. | Stamps and tables | |
| Vulture [b] | Vulture | Amalgamation, concentration, cyanidation. | Crushers, stamps, tables, 3 cyanide tanks (200 tons). | 100 |
| MOHAVE COUNTY. | | | | |
| Doyle [a] | Aubrey | Cyanidation | | |
| Siamese & Pittsburg [a] | Cedar Valley | Amalgamation | 3 stamps, plates | 3 |
| Cedar Valley [a] | do | Amalgamation, cyanidation. | 15 stamps | 150 |
| Cyclopic [b] | Gold Basin | Cyanidation | Ellspass mill | 20 |
| Crescent [a] | Hackberry | Amalgamation | 5 stamps | 15 |
| Lucknow [a] | do | do | Chilean mill | |
| Expansion [a] | San Francisco | Cyanidation | 10 stamps | 40 |
| Gold Crown [b] | do | do | Ball and tube mills | 60 |
| Gold Road [b] | do | do | Stamps, tube mill, Chilean mills, filters, 8 cyanide tanks. | 300 |
| Hercules [a] | do | do | 5 stamps | 15 |
| Pioneer Cons. [a] | do | Amalgamation, cyanidation. | 10 stamps | 40 |
| Ruth-Rattan [b] | do | Cyanidation | 20 stamps | 60 |
| Tom Reed [b] | do | do | Crusher, 20 stamps, 2 tube mills, 4 cyanide tanks (240 tons). | 150 |
| Victor and Virgin [a] | do | do | 20 stamps and tube mill. | 60 |
| Golconda [b] | Union Basin | Concentration | Crusher, rolls, jigs, tables. | 100 |
| Bi-Metal [a] | Wallapai | Amalgamation | Huntington mill and 10 stamps. | 30 |
| Pinkham [a] | do | do | 4 stamps | 12 |
| C. O. D. [b] | do | Concentration | Rolls and Bartlett table. | 40 |
| Golden Gem [a] | do | Amalgamation, concentration. | 4 Nissen stamps | 25 |
| Keystone [a] | do | Amalgamation | 5 stamps | 15 |
| Midnight [a] | do | do | 10 stamps | 30 |
| Oro Plata [b] | do | Concentration | Crusher, tables | 40 |
| Redemption [a] | do | do | do | 25 |
| Utah-Arizona [a] | Weaver | Amalgamation | 5 stamps | 15 |
| Gold Bug [a] | do | do | Huntington mill | 25 |
| Dandy [a] | do | Amalgamation, concentration. | 5 stamps | 15 |

[a] Idle in 1911. [b] Active in 1911.

*List of reduction mills in Arizona in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| PIMA COUNTY. | | | | |
| New Cornelia [a] | Ajo | Concentration | Crusher, 10 stamps, and 4 Wilfley tables. | *Short tons.* 75 |
| Ajo [b] | do | do | 15 stamps and 3 Wilfley tables. | 50 |
| Oceanic [a] | Arivaca | Amalgamation | 3 stamps | 15 |
| Cerro-Colorado [a] | do | Concentration | 5 stamps | 15 |
| Cababi [a] | Cababi | Concentration, cyanidation. | 15 stamps, 25-ton cyanide plant. | 25 |
| Helena [a] | Helena | Amalgamation | | 35 |
| Tip Top [a] | do | Concentration | Crusher and tables | |
| Wayne [a] | Quijotoa | Amalgamation | 10 stamps | 30 |
| Weldon [a] | do | Amalgamation, concentration. | do | |
| Isabelle [a] | Saltwell | Amalgamation | Lane slow speed Chilean mill. | 40 |
| El Tiro [a] | Silver Bell | Concentration | Huntington mill and rolls, Richards classifiers, tables. | 100 |
| Imperial [a] | do | do | Rolls, 6 Century jigs, 22 Card tables, and 20 vanners. | 300 |
| PINAL COUNTY. | | | | |
| Copper Creek [a] | Bunker Hill | Concentration | Crusher, tables | 100 |
| Desert Queen [a] | Casa Grande | Cyanidation | Tremain double steam stamp mill. | 20 |
| Turning Point [b] | do | Amalgamation, concentration. | 10 stamps and tables | 30 |
| Vekol [a] | do | Concentration | 10 stamps | 50 |
| Mammoth [b] | Goldfield | Amalgamation | Gates crusher, 10 stamps. | 20 |
| Campo Bonita [a] | Old Hat | Amalgamation, concentration. | Used for gold, tungsten ores, 5 stamps. | 15 |
| Mohawk [b] | do | Amalgamation | 30 stamps | 100 |
| Superstition Mountain [a] | Pioneer | Concentration, cyanidation. | Huntington mill | 50 |
| SANTA CRUZ COUNTY. | | | | |
| Mowry [a] | Patagonia | Concentration | Crushers, rolls, Wilfley tables, Frue vanners. | 100 |
| Duquesne [a] | do | do | Crushers, tables | 200 |
| Trenton [a] | Tyndall | do | Crushers, tables | 50 |
| YAVAPAI COUNTY. | | | | |
| Pick and Drill [b] | Agua Fria | Amalgamation, concentration. | 6 stamps | 25 |
| Poland Extension [a] | Big Bug | do | Huntington mills and tables. | 80 |
| Iron King [a] | do | Concentration, cyanidation. | 12 stamps and cyanide plant. | 40 |
| McCabe-Gladstone [a] | do | Concentration | 10 stamps and Ellspass mill. | 80 |
| Braganza [a] | do | Cyanidation | 20 stamps | 50 |
| Poland [b] | do | Amalgamation, concentration. | Crusher, 20 stamps, Card tables. | 50 |
| Dividend [a] | do | Concentration | 20 stamps | 60 |
| Galena [a] | do | Amalgamation, concentration. | 5 stamps, and 1 Wilfley table. | 15 |
| Lelan [a] | do | do | 10 stamps | 30 |
| Independent and Union No. 2. [b] | do | do | 10 stamps, plates, and tables. | 18 |
| Oriental [a] | do | do | 10 stamps | 30 |
| Gold Note [a] | Black Canyon | Amalgamation, concentration, cyanidation. | do | 30 |
| Parker [a] | do | do | 5 stamps | 15 |
| Hidden Treasure [a] | do | Amalgamation | 10 stamps | 30 |
| Texas & Wren [c] | Black Rock | Amalgamation, concentration. | do | 30 |
| Big Blue [a] | do | Concentration | 5-foot Bryan mill, 2 Deister tables. | 40 |
| Dboler [b] | do | Amalgamation | 5 stamps, battery plate. | 15 |

[a] Idle in 1911. [b] Active in 1911. [c] Under construction in 1911.

*List of reduction mills in Arizona in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| YAVAPAI COUNTY—con. | | | | *Short tons.* |
| Mountain View [a] | Black Rock | Cyanidation | | 50 |
| O'Brien [a] | do | Amalgamation, concentration, cyanidation. | 12 Nissen stamps | 50 |
| Orogrande [a] | do | Amalgamation | 10 stamps | 55 |
| Dark Horse [a] | do | Amalgamation, concentration. | 40 stamps | 70 |
| Ventura [a] | Castle Creek | Amalgamation | | 40 |
| Gold Lode [b] | Cherry Creek | Amalgamation, concentration. | Slow-speed Lane mill. | 40 |
| Federal [b] | do | Amalgamation, concentration, cyanidation. | Crusher | 50 |
| Statehood [a] | do | Amalgamation, concentration. | 10 stamps | 14 |
| Hillside [b] | do | do | 3 Nissen stamps | 15 |
| Verde River [a] | do | Cyanidation | Chilean mills | 150 |
| Copper Basin [a] | Copper Basin | Amalgamation, concentration. | 20 stamps | 50 |
| Hillside [b] | Eureka | Concentration | 5 stamps | 15 |
| Nieman [b] | do | Amalgamation | 10 stamps | 30 |
| Pocahontas [a] | do | do | 5 stamps | 15 |
| Climax [b] | Hassayampa | Amalgamation, concentration. | 10 stamps, plates, and table. | 30 |
| Cash [a] | do | Amalgamation | 10 stamps | 30 |
| Gold Basin [a] | do | Amalgamation, concentration. | 5 stamps | 15 |
| Empire [a] | do | Concentration | 10 stamps | 30 |
| Independence [a] | do | Cyanidation | 1 Lane mill, 5 cyanide tanks. | 20 |
| Little Kid [a] | do | Amalgamation, concentration, cyanidation. | 10 stamps | 25 |
| Home Run [a] | do | do | Crushers, tables | 50 |
| Midnight Test [a] | do | Amalgamation, concentration. | 6 Nissen stamps, 2 Wiffley tables, Frue vanners. | 30 |
| Mount Union [a] | do | do | 2 Huntington mills | 30 |
| Dunkirk [a] | do | Concentration | 4 Nissen stamps | 30 |
| Sundance [a] | do | do | Crushers and tables | 75 |
| Sunnyside [a] | do | Amalgamation, concentration. | Huntington mill and plates. | |
| Sterling [a] | do | Concentration | 20 stamps | 50 |
| Big Pine [b] | do | Amalgamation, concentration. | 5-foot Huntington mills, plates, and tables. | |
| Coover [a] | Humbug | do | 10 stamps | 30 |
| Nolan [a] | do | Amalgamation, concentration, cyanidation. | Plates, tables, and tanks. | 20 |
| Congress [b] | Martinez | Concentration, cyanidation. | 80 stamps, mills, 10 cyanide tanks (100 tons). | 150 |
| Chicago [a] | do | Cyanidation | 20 stamps | 50 |
| Alaska [b] | do | Concentration, cyanidation. | 4 Nissen stamps, sand vats, and agitation. | 30 |
| Emmet [a] | Mineral Point | Amalgamation, concentration. | 5 stamps | 15 |
| Golden Belt [b] | Peck | do | 2 Tremain stamps | 20 |
| De Soto [a] | do | Concentration | 2 Blake crushers, 2 centrifugal crushers, 2 sets of rolls, 2 jigs, 16 vanners, 16 Overstrom tables. | 350 |
| Lincoln [b] | do | Amalgamation, concentration. | Stamps and plates | 75 |
| Buster [a] | Pine Grove | Amalgamation | 5 stamps | 15 |
| Old Tiger [b] | do | Concentration | 10 stamps and tables | 100 |
| Monte Carlo [a] | Silver Mountain | Amalgamation | 2 stamps | 3 |
| Tip Top Heath [c] | do | Concentration | Crushers and tables | |
| White Horse [a] | Squaw Creek | Amalgamation | 10 stamps | 30 |
| Tiger Group [b] | Tiger | Amalgamation, concentration. | Crusher, stamps, and tables. | 75 |
| Derby [a] | Thumb Butte | Concentration | 5 stamps | 15 |

[a] Idle in 1911. [b] Active in 1911. [c] Under construction in 1911.

*List of reduction mills in Arizona in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| YAVAPAI COUNTY—con. | | | | *Short tons.* |
| New Cumberland [a] | Turkey Creek | Amalgamation, concentration. | 10 stamps | 30 |
| North Capitol [b] | Walker | do | 5-foot Huntington mill, plates, and tables. | 50 |
| Pine Mountain [a] | do | do | 10 stamps | 30 |
| Mudhole [b] | do | Concentration | Crusher, 5-foot Huntington mill, plates, tables. | 175 |
| Big Butte [a] | Walnut Grove | Amalgamation | 5 stamps | 15 |
| Old Spaniard [a] | do | do | 3½-foot Huntington mill. | 12 |
| Alvarado [a] | Weaver | Cyanidation | 20 stamps, 2 tube mills, Butters filter. | 200 |
| Yarnell [a] | do | Amalgamation, cyanidation. | 20 stamps | 60 |
| Mayflower and Sixty-Five [a] | do | Amalgamation, concentration. | 10 stamps | 30 |
| Monica [a] | do | Amalgamation, cyanidation. | 5 stamps | 12 |
| Octave [a] | do | Amalgamation, concentration, cyanidation. | 40 stamps, batteries, plates, tables. | 135 |
| Gold Hill [a] | do | Amalgamation | 2 stamps | 10 |
| Weaver Mountain [b] | do | Amalgamation, concentration. | 10 stamps (1,000 pounds each). | 40 |
| Monarch [c] | White Picacho | Concentration | Crusher and tables | 100 |
| YUMA COUNTY. | | | | |
| Bonanza and Golden Eagle [a] | Ellsworth | Amalgamation, cyanidation. | 40 stamps | 70 |
| Desert [b] | do | Amalgamation, concentration. | 10 stamps and tables | 50 |
| Grand Central [a] | do | Amalgamation | 10 stamps | 30 |
| Socorro [b] | do | Amalgamation, concentration. | 20 stamps and tables | 100 |
| Gloriosa [a] | Hydra | Amalgamation | 10-foot rolls, Chilean mill. | 40 |
| North Star [b] | Kofa | Amalgamation, cyanidation. | Crusher, rolls, tube mill, agitation equipment. | 100 |
| King of Arizona [a] | do | Cyanidation | | 200 |
| Goodman [b] | Plomosa | Amalgamation, concentration. | 1 Nissen stamp, crusher, plates. | 5 |
| Copper Prince [a] | do | Concentration | Crusher and tables | |
| Stafford [b] | do | Amalgamation | Slow-speed Lane mill, crusher, tables. | 10 |

[a] Idle in 1911. [b] Active in 1911. [c] Under construction in 1911.

The building of new and the remodeling of old mills was actively carried on in Arizona in 1911. The new concentrator at Miami was finished, its last unit having been set to work. The concentrator at Hayden was nearing completion. A 5,000-ton mill for the Inspiration mine, near Globe, is being planned, and an entirely new plant has been authorized by the Arizona Copper Co. near Morenci. At the Ray Consolidated mill 4 sections of the 8,000-ton concentrator were operated, treating 3,500 tons of ore daily with an average extraction of 70 per cent. Production began in March. The capacity of the Gold Roads mill, in Mohave County, was increased from 200 to 250 tons of ore daily. Arizona has 160 milling plants, of which there were 46 in operation in 1911, but some of them were operated for only short periods. Of these active mills 5 used cyanidation alone, 2 used amalgamation and cyanidation, 17 used amalgamation and concentration, 13 used only concentration, 5 used amalgamation alone, and 2 used amalgamation, concentration, and cyanidation.

The Survey list includes several old and partly equipped mills, which have practically been abandoned. There were 3 new mills reported under construction. The mills equipped for the cyanidation process produced bullion yielding $1,680,121 in gold and 44,776 ounces of silver. The mills equipped with the amalgamation process yielded bullion containing $234,555 in gold and 4,386 ounces of silver. From 22,475 tons of ore treated by the amalgamation process, 1,679 tons of concentrate, in addition to the bullion, were produced, containing $65,089 in gold, 18,440 ounces of silver, and 43,047 pounds of copper. Over a third of the concentrate, or 600 tons, was sulphides, containing gold, silver, and a little copper, produced from the treatment of 16,628 tons of ore. The tailings of this ore were treated by cyanidation. All of the concentrates were sold to smelters; none of them were reported treated by the cyanide process. Reports were made by a number of bullion producers as to the total quantity of potassium cyanide and quicksilver consumed in 1911. For those who did not report estimates were made. No sodium cyanide was reported. The totals are as follows:

*Consumption of quicksilver and cyanide of potassium in Arizona in 1911, in pounds.*

| Quicksilver. | Potassium cyanide. | Sodium cyanide. |
|---|---|---|
| 1,362 | 115,877 | None. |

The average consumption of quicksilver per ounce of gold and silver bullion recovered was 0.086 pound and of potassium cyanide 0.919 pound.

*Quantity of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Arizona in 1911, by counties.*

| County. | Quantity. | Bullion recovered from ore by— | | | | Total value. |
|---|---|---|---|---|---|---|
| | | Amalgamation. | | Cyanidation. | | |
| | | Gold. | Silver. | Gold. | Silver. | |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Fine ounces.* | *Fine ounces.* | |
| Cochise | [a] 277 | 93.74 | 39 | ..... | ..... | $1,959 |
| Gila | [b] 73 | 28.69 | 5 | ..... | ..... | 596 |
| Greenlee | 26 | 29.20 | 14 | ..... | ..... | 611 |
| Maricopa | 11,351 | 2,677.19 | 845 | 1,937.69 | 1,870 | 96,838 |
| Mohave | 107,327 | 698.20 | 400 | 70,498.19 | 33,759 | 1,489,864 |
| Pima | 29 | 21.15 | 18 | ..... | ..... | 446 |
| Pinal | [c] 3,795 | 666.96 | 192 | ..... | ..... | 13,889 |
| Santa Cruz | [d] 200 | 28.50 | 21 | ..... | ..... | 600 |
| Yavapai | [e] 39,652 | 4,307.03 | 1,635 | 2,741.40 | 6,416 | 149,971 |
| Yuma | [f] 6,993 | 2,795.98 | 1,217 | 6,098.57 | 2,731 | 185,958 |
| Total | 169,723 | 11,346.64 | 4,386 | 81,275.85 | 44,776 | 1,940,732 |

[a] Also yielded besides gold and silver 10 tons of lead sulphide concentrates.
[b] Siliceous, 7 tons.
[c] Lead sulphide, 16 tons.
[d] Siliceous, 3 tons.
[e] Heavy oxide and sulphide, 1,831 tons; copper and iron sulphide, 42 tons; lead sulphide, 327 tons; and lead-zinc sulphide, 39 tons.
[f] Iron sulphide, 14 tons.

NOTE.—These tonnages and their metal contents are included in table of concentrates produced.

Near Paradise a 100-ton concentration mill was started in November. The 20-stamp amalgamation and cyanidation mill built in 1910 at the Vulture mine, in Maricopa County, has been in successful operation. New mill equipment was ordered for the Big Blue mine and the Monarch mine, the latter having been idle for three years. The Tom Reed and Gold Road mines, in Mohave County, produce gold-bearing ore, which is treated in cyanide plants. The former made an average output of nearly $65,000 in gold per month from the operation of its 20-stamp mill in 1911, and the latter, with a better grade of ore than formerly, averaged nearly the same amount from the treatment of about 200 tons daily. In the Union Pass district the Frisco mill, recently built, provides for fine grinding and cyanidation. Two other gold mills, the Gold Crown and the Ruth, were operated. In Todd Basin the Oro Plata mill is under construction. The new owners of the Southern Bell mine, in Pinal County, have ordered a 100-ton mill. The Huebabi mill, on Santa Cruz River, in Santa Cruz County, was recently equipped with a tube mill and cyanide plant. Large bodies of low-grade ore are reported to exist in this mine. The Congress mine and mill, in Yavapai County, were closed after being operated the first three months of 1911. At the Monica and Rincon gold mines preparations were made to operate. The Tiger mine and mill, near Crown King, were operated steadily, producing gold bullion and lead concentrates. Grading was commenced for the cyanide mill on the Venezia mine, in Crook Canyon. In Yuma County, the Lane mill at the Safford mine, near Vicksburg, was in regular operation, and the North Star, at Kofa, for part of the year.

*Mine production of gold, silver, copper, lead, and zinc from Arizona concentrates in 1911, by counties.*

| County. | Ore to concentrating mills. | Concentrates produced. | | | | | | Total value of concentrates. |
|---|---|---|---|---|---|---|---|---|
| | | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Cochise | | 10 | 54.00 | 223 | 404 | 7,445 | | $1,620 |
| Gila | 585,498 | 66,310 | 1,350.24 | 150,287 | 25,925,235 | | | 3,348,218 |
| Greenlee | 1,323,447 | 202,000 | 195.99 | 12,443 | 53,357,822 | | | 6,680,375 |
| Mohave | 25,184 | 7,419 | 2,440.15 | 72,852 | 19,772 | 2,337,663 | 3,084,612 | 372,543 |
| Pima | 600 | 131 | 10.48 | 393 | 110,040 | | | 14,181 |
| Pinal | 682,120 | 35,705 | 8.00 | 21,355 | 15,736,271 | 6,643 | | 1,978,817 |
| Santa Cruz | | 3 | 6.20 | 42 | 75 | | | 159 |
| Yavapai | 6,928 | 3,134 | 6,820.60 | 129,476 | 50,836 | 161,430 | 8,913 | 223,743 |
| Yuma | 350 | 49 | 54.23 | 1,102 | | 50,749 | | 3,989 |
| Total | 2,624,037 | 314,761 | 10,939.89 | 388,173 | 95,200,455 | 2,563,930 | 3,093,525 | 12,623,645 |
| Subdivision by kinds of concentrates: | | | | | | | | |
| Dry or siliceous | | 2,692 | 5,987.83 | 125,513 | 43,029 | 31,356 | | 197,092 |
| Copper | | 304,165 | 1,615.60 | 184,365 | 95,134,213 | | | 12,022,888 |
| Lead | | 3,813 | 2,274.94 | 47,563 | 17,033 | 2,361,671 | | 180,641 |
| Zinc | | 4,045 | 961.96 | 29,753 | 4,897 | 142,941 | 3,084,612 | 218,521 |
| Copper-lead | | 7 | 52.00 | 179 | 404 | 4,490 | | 1,422 |
| Lead-zinc | | 39 | 47.56 | 800 | 879 | 23,472 | 8,913 | 3,081 |

*Kinds of concentrates and average metallic content of milling ore and concentrates produced in Arizona in 1911.*

| Kinds of concentrates and source of production. | Milling ore. | Concentrate. | Average metallic content per ton. | | | | | | | | | | Average value per ton. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gold. | | Silver. | | Copper. | | Lead. | | Zinc. | | | |
| | | | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. |
| | *Short tons.* | *Short tons.* | | | *Fine ounces.* | *Fine ounces.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | | |
| Dry or siliceous: | | | | | | | | | | | | | | |
| Gold and silver mills | 34,349 | 1,855 | $3.27 | $60.52 | 0.48 | 8.92 | 0.05 | 0.98 | | | | | $3.66 | $67.71 |
| Concentration mills | 6,804 | 837 | 1.69 | 13.75 | 16.01 | 130.17 | .05 | .39 | 0.23 | 1.87 | | | 10.51 | 85.42 |
| Copper: | | | | | | | | | | | | | | |
| Gold and silver mills | 450 | 42 | 3.24 | 34.71 | 1.90 | 20.33 | .55 | 5.94 | | | | | 5.63 | 60.36 |
| Concentration mills | 2,591,575 | 304,123 | .01 | .11 | .07 | .60 | 1.84 | 15.64 | | | | | 4.64 | 39.52 |
| Lead: | | | | | | | | | | | | | | |
| Gold and silver mills | 3,907 | 346 | 4.34 | 48.99 | .94 | 10.44 | .03 | .31 | .64 | 6.28 | | | 5.48 | 61.85 |
| Concentration mills | 11,658 | 3,467 | 2.58 | 8.68 | 3.77 | 12.68 | .06 | .21 | 9.91 | 33.33 | | | 13.66 | 45.93 |
| Zinc: | | | | | | | | | | | | | | |
| Concentration mills | 24,756 | 4,045 | .80 | 4.91 | 1.20 | 7.36 | .01 | .06 | .29 | 1.77 | 6.23 | 38.13 | 8.83 | 54.02 |
| Copper-lead: | | | | | | | | | | | | | | |
| Gold and silver mills | 260 | 7 | 4.13 | 153.57 | .69 | 25.57 | .07 | 2.88 | .86 | 32.07 | | | 5.47 | 203.14 |
| Lead-zinc: | | | | | | | | | | | | | | |
| Gold and silver mills | 130 | 39 | 7.56 | 25.21 | 6.15 | 20.51 | .34 | 1.13 | 9.03 | 30.09 | 3.43 | 11.43 | 23.70 | 79.00 |

Nearly all of the copper ores mined in the State are treated at the Arizona smelters, except some copper concentrate, which, in 1911, was diverted to two smelting plants in Mexico, at Aguascalientes and Cananea. The lead ores were shipped principally to smelters at El Paso, Tex., and Needles, Cal. Zinc ore and concentrates were shipped to Colorado, Kansas, and Oklahoma. Only a small quantity of silver bullion was shipped east. The gold and silver bullion produced by amalgamation and cyanidation was sold to the United States mints, assay offices, and bullion buyers at Denver, New Orleans, Philadelphia, New York, and San Francisco.

## SMELTING IN ARIZONA IN 1911.

Smelting plants in Arizona treating copper ores were in active operation in 1911, 2 at Douglas, in Cochise County; 3 at Clifton and Morenci, in Greenlee County; 2 in Yavapai County, at Humboldt and Jerome; and 1 in Gila County, near Globe. At Hayden, in Gila County, construction work was resumed on the new copper smelter of the American Smelting & Refining Co. The construction of this smelter was originally begun by the Ray Consolidated Co. A decision was reached by the Arizona Copper Co., at Clifton, to abandon the old and erect new smelting works, exclusively on the reverberatory system, it is reported, the object being to achieve greater economy in smelting rather than increase in production. The Copper Queen Co. was putting in two new reverberatories, and the Calumet & Arizona, at Douglas, was remodeling the old works at Douglas, increasing the capacity, and adding roasting and reverberatory furnaces. At the United Verde, new works are being planned with the object of getting a more central situation for treating the ore production of the district. At the Old Dominion, as elsewhere, the increased quantity of concentrates and the decreased quantity of crude ore obtained points to modifications in the company's smelting methods. The Sasco smelter, in Pima County, was idle. The Arizona-United, at Johnson, and the Benson plant were idle; and the Swansea copper smelter of the Clara Consolidated operated only a short time, producing a small quantity of blister copper. Construction of the new Pioneer copper plant, with a daily capacity of 150 tons, was started near Twin Buttes, in Pima County.

*Mine production of gold, silver, copper, lead, and zinc from Arizona crude ore shipped to smelters in 1911, by counties.*

| County. | Crude ore to smelter. | | | | | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Cochise | 1,162,969 | 37,694.15 | 1,933,092 | 132,289,603 | 6,899,943 | 22,423 | $18,651,722 |
| Coconino | 330 | ..... | 76 | 13,594 | ..... | ..... | 1,739 |
| Gila | 122,716 | 1,041.56 | 97,482 | 22,085,158 | 10,466 | ..... | 2,834,312 |
| Graham | 33 | 1.02 | 204 | 365 | 24,982 | ..... | 1,299 |
| Greenlee | 227,747 | 1,300.61 | 91,972 | 17,568,508 | 30,734 | ..... | 2,273,078 |
| Maricopa | 10 | 17.80 | 16 | 729 | ..... | ..... | 467 |
| Mohave | 3,413 | 1,231.66 | 36,958 | 224,606 | 253,926 | 1,391,940 | 163,893 |
| Pima | 7,581 | 54.52 | 13,525 | 874,697 | 23,506 | ..... | 118,690 |
| Pinal | 242 | 29.00 | 8,361 | 75,552 | 81,311 | ..... | 18,134 |
| Santa Cruz | 878 | 40.81 | 12,687 | 122,642 | 193,000 | 16,844 | 32,542 |
| Yavapai | 196,311 | 18,553.41 | 620,962 | 36,039,169 | 156,659 | 38,252 | 5,226,769 |
| Yuma | 5,161 | 724.81 | 4,538 | 416,868 | 36,095 | ..... | 71,121 |
| Total | 1,727,451 | 60,689.35 | 2,819,873 | 209,711,491 | 7,710,622 | 1,469,459 | 29,393,766 |

*Mine production of gold, silver, copper, lead, and zinc from Arizona crude ore shipped to smelters in 1911, by counties*—Continued.

| County. | Crude ore to smelter. | | | | | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| Subdivision by kinds of ore: | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Dry or siliceous. | 48,037 | 3,791.70 | 215,892 | 650,084 | 7,505 | ..... | $274,402 |
| Copper | 1,655,989 | 49,828.85 | 1,952,596 | 208,780,152 | 28,645 | ..... | 28,163,738 |
| Lead | 21,190 | 6,616.20 | 629,239 | 268,976 | 7,464,553 | ..... | 839,793 |
| Zinc | 2,106 | 439.60 | 17,044 | 1,676 | 108,322 | 1,469,459 | 106,963 |
| Copper-lead | 129 | 13.00 | 5,102 | 10,603 | 101,597 | ..... | 8,870 |

*Crude ore, by kinds, and average metallic content of each kind shipped to smelters in Arizona in 1911.*

| Kind of crude ore. | Quantity. | Average metallic content. | | | | | Average value per ton. |
|---|---|---|---|---|---|---|---|
| | | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | *Ounces per ton.* | *Ounces per ton.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Dry or siliceous | 48,037 | $1.63 | 4.49 | 0.68 | 0.01 | ..... | $5.71 |
| Copper | 1,655,989 | .62 | 1.18 | 6.30 | ..... | ..... | 17.01 |
| Lead | 21,190 | 6.45 | 29.69 | .63 | 17.61 | ..... | 39.63 |
| Zinc | 2,106 | 4.31 | 8.09 | .04 | 2.57 | 34.89 | 50.79 |
| Copper-lead | 129 | 2.08 | 39.55 | 4.11 | 39.38 | ..... | 68.76 |

## MINING INDUSTRY IN 1911.

Development, more economical methods of mining, or the consolidation of adjacent properties to decrease the cost of working the deposits, characterized the year's work. Operation at the new low-grade copper mines progressed beyond the development stage and brought the production of the State to a somewhat higher figure than the maximum of any previous year. Courtland Camp, in the Dragoon Mountains, which promised to be a prominent producer three years ago, did not realize expectations. The Bagdad Copper Co., operating north of Hillside, in Yavapai County, is said to have developed a 2 per cent disseminated copper deposit, containing five or six million tons of ore. At Ajo, in Pima County, the copper properties were bonded by the Calumet & Arizona Co., and an attempt was made to prospect the ground by churn drilling, but some difficulty was found which closed operations. In the Old Hat district, Pinal County, the Copper Queen Consolidated Mining Co. continued development on mining claims which cover a part of the extensive garnet zones of the Marble Peak district. The famous Commonwealth mine, Cochise County, was bonded to the Montana Tonopah Mining Co. After the closing of the Silver King, Vekol, and Tombstone properties, silver mining in Arizona declined, recovering slightly when operations at the Commonwealth and the Tombstone mines were renewed. The deeper levels of the latter were closed again in 1911, when it was found the cost of pumping 7,000,000 gallons of water with a 1,000-foot lift was not economical. An attempt to reopen the Vekol silver mine, Pinal County, was also abandoned in 1911 on account of water troubles.

*Mine production of gold, silver, copper, lead, and zinc in Arizona in 1911, by counties.*

| County. | Gold. | | | | Silver. | |
|---|---|---|---|---|---|---|
| | Placers. | | Deep mines. | | | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | *Fine ozs.* | | *Fine ozs.* | | *Fine ozs.* | |
| Cochise | 5.51 | $114 | 37,919.57 | $783,867 | 1,946,319 | $1,031,549 |
| Coconino | | | | | 76 | 40 |
| Gila | 13.26 | 274 | 2,420.49 | 50,036 | 247,813 | 131,341 |
| Graham | | | 1.01 | 21 | 204 | 108 |
| Greenlee | | | 1,525.79 | 31,541 | 104,429 | 55,347 |
| Maricopa | 46.53 | 962 | 4,632.69 | 95,766 | 2,736 | 1,450 |
| Mohave | | | 74,868.20 | 1,547,663 | 143,969 | 76,304 |
| Pima | 185.90 | 3,843 | 86.16 | 1,781 | 13,965 | 7,402 |
| Pinal | 56.16 | 1,161 | 703.96 | 14,552 | 29,914 | 15,855 |
| Santa Cruz | 29.95 | 619 | 75.51 | 1,561 | 12,755 | 6,760 |
| Yavapai | 463.48 | 9,581 | 32,899.98 | 680,103 | 764,744 | 405,314 |
| Yuma | 342.84 | 7,087 | 9,673.59 | 199,971 | 9,647 | 5,113 |
| Total | 1,143.63 | 23,641 | 164,806.95 | 3,406,862 | 3,276,571 | 1,736,583 |

| County. | Copper. | | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | *Pounds.* | | |
| Cochise | 132,290,007 | $16,536,251 | 6,907,388 | $310,832 | 22,423 | $1,278 | $18,663,891 |
| Coconino | 13,594 | 1,699 | | | | | 1,739 |
| Gila | 49,226,341 | 6,153,293 | 10,466 | 471 | | | 6,335,415 |
| Graham | 365 | 46 | 24,982 | 1,124 | | | 1,299 |
| Greenlee | 70,926,330 | 8,865,791 | 30,734 | 1,383 | | | 8,954,062 |
| Maricopa | 729 | 91 | | | | | 98,269 |
| Mohave | 244,378 | 30,547 | 2,591,589 | 116,622 | 4,476,552 | 255,164 | 2,026,300 |
| Pima | 984,737 | 123,092 | 23,506 | 1,058 | | | 137,176 |
| Pinal | 15,811,823 | 1,976,478 | 87,954 | 3,958 | | | 2,012,004 |
| Santa Cruz | 122,717 | 15,339 | 193,000 | 8,685 | 16,844 | 960 | 33,924 |
| Yavapai | 36,103,649 | 4,512,956 | 318,089 | 14,314 | 47,165 | 2,688 | 5,624,956 |
| Yuma | 416,868 | 52,109 | 86,844 | 3,908 | | | 268,188 |
| Total | 306,141,538 | 38,267,692 | 10,274,552 | 462,355 | 4,562,984 | 260,090 | 44,157,223 |

*Tons of ore sold or treated, number of deep mines producing, and value of ores in Arizona in 1910 and 1911, by counties.*

| County. | Ore sold or treated. | | Number of deep mines producing. | | Average total value per ton.[a] | | Average value per ton in gold and silver.[a] | |
|---|---|---|---|---|---|---|---|---|
| | 1911 | Increase (+) or decrease (−). | 1910 | 1911 | 1910 | 1911 | 1910 | 1911 |
| | *Short tons.* | *Short tons.* | | | | | | |
| Cochise | 1,167,237 | −127,045 | 37 | 43 | $15.25 | $15.99 | $0.96 | $1.55 |
| Coconino | 390 | − 1,219 | 2 | 3 | 5.33 | 4.46 | .24 | .10 |
| Gila | 735,432 | +423,375 | 44 | 43 | 13.13 | 8.61 | .38 | .25 |
| Graham | 33 | + 15 | 1 | 1 | 55.28 | 39.36 | 4.39 | 3.91 |
| Greenlee | 1,551,220 | − 9,947 | 23 | 23 | 6.01 | 5.77 | .08 | .06 |
| Maricopa | 19,256 | + 6,958 | 6 | 4 | 5.37 | 5.05 | 5.33 | 5.05 |
| Mohave | 140,402 | + 41,119 | 40 | 47 | 16.12 | 14.43 | 12.14 | 11.57 |
| Pima | 8,210 | −169,465 | 25 | 19 | 4.80 | 16.24 | .34 | 1.12 |
| Pinal | 686,212 | +685,973 | 15 | 21 | 39.30 | 2.93 | 30.85 | .05 |
| Santa Cruz | 1,078 | + 285 | 21 | 17 | 72.39 | 30.89 | 58.92 | 7.72 |
| Yavapai | 245,165 | −172,143 | 87 | 94 | 15.44 | 22.91 | 2.99 | 4.42 |
| Yuma | 12,504 | − 25,736 | 28 | 40 | 11.39 | 20.88 | 10.15 | 16.40 |
| Total | 4,567,139 | +652,170 | 329 | 355 | 10.91 | 9.66 | 1.15 | 1.13 |

[a] Value per ton, placer product excluded.

*Number of mines in Arizona classified by chief products in 1911.*

| County. | Placer. | Gold. | Silver. | Copper. | Gold, silver. | Gold, copper. | Gold, silver, copper. | Gold, silver, lead. | Gold, silver, copper, lead. | Gold, silver, copper, lead, zinc. | Gold, silver, lead, zinc. | Silver, copper. | Silver, lead. | Silver, copper, lead. | Total mines producing. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cochise | 1 | 1 | 2 | 1 | 3 | .... | 5 | 3 | 12 | 1 | ..... | 9 | 1 | 5 | 44 |
| Coconino | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3 | ..... | ..... | 3 |
| Gila | 1 | ..... | ..... | ..... | 1 | 6 | 17 | ..... | 2 | ..... | ..... | 13 | ..... | 4 | 44 |
| Graham | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1 | ..... | ..... | ..... | ..... | ..... | 1 |
| Greenlee | ..... | ..... | ..... | 5 | 9 | .... | 5 | 1 | ..... | ..... | ..... | 2 | 1 | ..... | 23 |
| Maricopa | 3 | ..... | ..... | ..... | 2 | 1 | 1 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 7 |
| Mohave | ..... | 1 | ..... | ..... | 18 | .... | 3 | 5 | 14 | 4 | 1 | 1 | ..... | ..... | 47 |
| Pima | 3 | 1 | ..... | ..... | 2 | .... | 6 | ..... | 2 | ..... | ..... | 3 | ..... | 5 | 22 |
| Pinal | 2 | ..... | ..... | ..... | 7 | .... | 2 | 1 | 2 | ..... | ..... | 5 | 2 | 2 | 23 |
| Santa Cruz | 2 | ..... | ..... | ..... | ..... | ..... | 2 | ..... | 5 | [a]1 | ..... | 6 | ..... | 3 | 19 |
| Yavapai | 15 | 2 | 4 | 1 | 26 | 1 | 34 | 7 | 13 | 2 | ..... | 1 | 2 | 1 | 109 |
| Yuma | 15 | 3 | .... | 1 | 11 | 5 | 9 | 2 | 3 | ..... | ..... | 2 | 3 | 1 | 55 |
| Total | 42 | 8 | 6 | 8 | 79 | 13 | 84 | 19 | 54 | 8 | 1 | 45 | 9 | 21 | 397 |

[a] Contains no gold.

## PRODUCTION BY COUNTIES.

### COCHISE COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Cochise County, Ariz., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 28,419.15 | $587,476 | 37,925.08 | $783,981 | + 9,505.93 | + $196,505 |
| Silver.....do.... | 1,208,274 | 652,468 | 1,946,319 | 1,031,549 | + 738,045 | + 379,081 |
| Copper.....pounds.. | 145,310,623 | 18,454,449 | 132,290,007 | 16,536,251 | −13,020,616 | −1,918,198 |
| Lead.....do.... | 1,176,416 | 51,762 | 6,907,388 | 310,832 | + 5,730,972 | + 259,070 |
| Zinc.....do.... | ..... | ..... | 22,423 | 1,278 | + 22,423 | + 1,278 |
| Total..... | ..... | 19,746,155 | ..... | 18,663,891 | ..... | −1,082,264 |

In 1911 the production of ore from Cochise County aggregated in total value $18,663,891, a decrease from the production of 1910, when the total value reached $19,746,155. Forty-three deep mines yielded 1,167,237 tons of ore, as against 37 deep mines producing an output of 1,294,282 tons in 1910. The decrease in the production is attributable to the lessened activity of the Tombstone mines and those operating at Courtland, in the vicinity of Pearce. Nearly all of the ore, or 1,104,406 tons, was copper ore, produced in the Warren district and treated at the smelters at Douglas. A small quantity of fluxing material was diverted to Globe. The average value per ton increased from $15.25 in 1910 to $15.99 in 1911, and the gold and silver average value of this ore, which, in 1910, was $0.96, increased to $1.55. The copper ores of shipping grade treated at the smelters aggregated 1,104,406 tons and contained $638,618 in gold, 1,296,786 ounces of silver, 131,443,499 pounds of copper, and 125 pounds of lead, having a value of $17,756,358 and an average of $16.08 per ton. No ore was treated in concentration mills in 1911, and the results were small from the operations of gold and silver mills, the shipments aggregating only $1,959, as against a yield of

$19,128 in 1910. A trial shipment of zinc ore was made to eastern markets. Only one operator reported placer production for 1911.

*California district.*—Six producers shipped 285 tons of ore of smelting grade, of which 170 tons were gold and silver siliceous ore and the remainder was carbonate and sulphide ores, containing a little copper and some gold and silver. The total metallic content was $100 in gold, 2,247 ounces of silver, 3,396 pounds of copper, and 24,028 pounds of lead, in all valued at $2,796, or an average of $9.81 per ton. The principal producers were the Bernoudy and the Humboldt groups. The latter produced dry siliceous shipping ore, containing some chloride of silver, and the occurrence was also reported of alabandite (manganese sulphide) at a depth of 85 feet, which continued to the present depth of the shaft at 140 feet. The district is 15 miles north of Rodeo, N. Mex., which is the loading station for the mines. The new smelter for the Calumet & Arizona Co. is situated just south of the present plant. The smelter is to be equipped with a complete custom sampling mill, Cananea bedding system (with a capacity for 58,000 tons); two 48-inch by 40-foot blast furnaces; dust chamber 60 by 180 feet; steel stack lined with acid-proof tiling 350 feet high by 25 feet in diameter; four 19-foot by 100-foot reverberatories with foundation and building for fifth; twelve 21-foot Herreshoff roasting furnaces and suitable dust chamber, and six Great Falls converters, 12 feet in diameter. The plant is expected to be complete August 1, 1913.

*Cochise or Johnson district.*—The production of 301 tons of ore by 5 producers was a decrease in the production of smelting ore, which was 3,836 tons in 1910, with an average value of $12.39 per ton. The metallic output in 1911 was $1,075 in gold, 4,884 ounces of silver, 19,983 pounds of copper, 101,130 pounds of lead, and 22,423 pounds of zinc, in all valued at $11,992, an average of $39.84 per ton. The Texas-Arizona and Centurion mines were the principal producers. The former produced an oxidized iron-copper shipping ore, which was taken out from crosscutting and drifting in the development of the property. It is stated that the property has 150,000 tons of ore developed. The mine is opened by an incline shaft 625 feet deep. Operators of the Texas-Arizona shipped its lead ore to El Paso and the zinc ore to Colorado. The district is reached by a narrow-gage railroad 9 miles west from Cochise, a station on the Southern Pacific Railroad. The ores occur as contact-metamorphic replacements in limestone, cut by granite porphyry.

*Dos Cabezos district.*—The metallic production from 3 deep mines and 1 placer was valued at $7,812 in 1911. There were 375 tons of ore mined, of which 277 tons produced gold and silver bullion and lead concentrate. Crude ore shipped directly to smelters aggregated 98 tons, containing silver and copper. The largest part of the product was from the Dives property and was treated in a stamp mill, producing bullion and lead concentrates. The Bachelder and other claims of the Mascot Copper Co. were under development the entire year, and a shipment of oxidized and sulphide copper ore was made as a test. The 5-stamp mill on the Cottonwood property was operated a short time, producing bullion and lead concentrate. The district is situated 15 miles east of Willcox, on the Southern Pacific Railroad.

*Hartford or Huachuca district.*—Small shipments of copper ore, carrying small values in gold and silver, were shipped in 1911, averaging $93 in value per ton. The district is situated 12 miles west of Hereford, on the El Paso & Southwestern Railroad.

*Swisshelm district.*—A shipment of 471 tons of oxidized lead ores, carrying considerable values in gold and silver, was made from the Meade property, which is developed by a shaft 300 feet deep, to which depth the oxidized ore is still encountered.

*Teviston district.*—Only one small lot of ore, containing copper and silver, was shipped from a prospect in the district in 1911.

*Tombstone district.*—The production of 11 properties in 1911 was valued at $216,042, all of which was contained in ore of shipping grade aggregating 8,797 tons, which yielded $44,554 in gold, 224,098 ounces of silver, 68,209 pounds of copper, and 982,010 pounds of lead. The average value of this ore was $24.56 per ton. Lessees worked on the properties of the Tombstone Consolidated Mines Co. (Ltd.), as follows: Contention, Grand Central, Silver Thread, Empire, Tough Nut, Goodenough, and Lucky Cuss claims. The larger part of the shipments was oxidized ore with a siliceous gangue. The 40-stamp mill on the property was not operated during the year. Operations of the company ceased with the suspension of pumping, January, 1911. Important shipments of lead ore were also made by the operators of the Hershell and Old Guard properties.

*Turquoise or Courtland district.*[1]—From five producing mines, this district had a production of 57,094 tons of ore and 3,991 tons of old tailings shipped to smelters, which contained $21,996 in gold, 68,799 ounces of silver, 3,395,446 pounds of copper, and 12,391 pounds of lead, in all valued at $483,448, an average of $7.91 per ton. The largest ore output was made from the Copper Belle mine, which produces a large supply of iron sulphides, carrying values in gold and silver and a small quantity of copper for the smelting operations of the Shannon plant at Clifton. The property is opened by a shaft 300 feet deep. The next largest producer was the Great Western, at Courtland. The ores are mostly oxidized, some sulphides being found at a depth of 200 feet. The property was operated the entire year and yielded a fair grade of copper ore containing values in gold and silver. No mining was done at the Commonwealth property during 1911, but lessees shipped to copper smelters old tailings, which carried but small values in gold and silver. The tailings were valuable to the smelters for use as converter lining. At the Fluorine property the 2-stamp testing amalgamation mill and cyanide plant was operated on ores from the mine, which is opened by a shaft 110 feet deep. No work was performed at the Courtland property belonging to the Calumet & Arizona Co.[2] during 1911. In the Mary claim of the Great Western Mining Co., adjoining the Germania claim of the Calumet & Arizona Co., the oxide ore body, which crosses the side line between these claims, has been stoped with very good results.

*Warren district.*—All of the copper ores produced in this district in 1911 were smelted at Douglas, and the lead ores at El Paso, Tex. The yield aggregated 1,095,895 tons, which contained $699,722 in gold, 1,637,164 ounces of silver, 128,767,150 pounds of copper, and

[1] Ransome, F. L., The Turquoise copper-mining district, Arizona: Bull. U. S. Geol. Survey No. 530, 1912.

[2] Annual report for year ending Dec. 31, 1911.

5,671,877 pounds of lead, valued in all at $17,918,545, or an average of $16.35 per ton. The production of copper and lead smelting ores from this district was the largest in the State in 1911. The largest producer of ore was the Copper Queen mine, followed by the Calumet & Arizona-Superior-Pittsburg property. The ores produced at the present time are extremely heavy sulphides with some oxidized carbonate ores. The general average of the heavy iron sulphides in 1911 was 2 per cent of copper, 10 per cent of silica, 40 per cent of iron, and 44 per cent of sulphur. The general average of ores sold contained 6.25 per cent copper, 21 per cent silica, 0.6 per cent iron, 2.5 per cent calcium oxide, 7.5 per cent alumina, and 16.5 per cent sulphur. The Copper Queen produced slightly less copper in 1911 than in 1910. It is reported that no startling developments were made underground, but new discoveries more than kept pace with extraction. The combination of the Calumet & Arizona and the Superior & Pittsburg proved beneficial to both companies, as is already reflected in a notable increase in the output of copper. The only other notable producer in the district was the Shattuck-Arizona. From the Calumet & Arizona [1] mine, 212,370 tons of copper ore were smelted, yielding 21,476,739 pounds of refined copper, 216,987 ounces of silver, and 9,329 ounces of gold. The bullion recovered includes that from the smelting of 38,831 tons of fluxing ore. The smelting ore yielded 97.67 pounds of copper per ton, and the fluxing ore 13.4 pounds per ton. The regular ore as mined averaged 5.15 per cent of copper and the fluxing ore 1.06 per cent. The total amount of development work was 26,196.5 feet, compared with 30,849.7 feet in 1910. The main opening is the Oliver shaft, in which new oxide ore was opened on the 1,050-foot and 1,250-foot levels, and new sulphide ore on the 1,250-foot and 1,600-foot levels. Dividends aggregating $1,989,059 were paid during 1911.

The Copper Queen [2] mines yielded 619,132 tons of copper and lead ore, shipped to Douglas, Globe, and El Paso smelters, and containing 16,132 ounces of gold, 1,227,453 ounces of silver, 74,489,728 pounds of copper, and 5,658,930 pounds of lead. The ore mined by lessees amounted to 17,317 tons, and increased greatly in quantity during 1911. It is in part derived from lead ores or plumbiferous copper ores. These are being exposed in quantity large enough to suggest the advisability of treating them all at the Douglas works. The Warren district first attracted attention as a lead-silver camp, and the first furnace erected was for the smelting of cerusite from the Hendricks claim.

* * * The amount of ore discovered during the past year has been gratifying, and according to the conventional methods of estimating, ore reserves have been maintained at approximately the same tonnage as during the past two years. The most interesting discovery has been in the Spray division of the mine, where a series of layers of sulphide ore have been partially developed in the Abrigo limestones of Cambrian age, thus encouraging the hope that older rocks than the Upper Devonian and Lower Carboniferous may carry copper ores in economical quantities. Another source of future production has been detected in the disseminated deposits of chalcocite in the porphyry beds of the Sacramento Mountain. Near the Uncle Sam shaft a very rich body of silver and gold ore, containing a little lead, has been found by lessees. The size and importance of this deposit has stimulated interest in ores of this character, and large quantities have been discovered in various parts of the mine, in the southwest country particularly. A notable profit should eventually be derived from this source.

[1] Annual report for year ending Dec. 31, 1911.
[2] Annual report Phelps, Dodge & Co. for year ending Dec. 31, 1911.

Production at the Superior & Pittsburg[1] property consisted of 206,234 tons of ore smelted, yielding refined bullion containing 28,469,166 pounds of copper, 236,960 ounces of silver, and 8,785 ounces of gold.

The average number of pounds of copper recovered amounted to 138.34 pounds per ton. Good sulphide ore was cut in the shaft at intervals from a depth of 1,700 feet to the bottom, and a small body of rich ore was developed in the 1,800-foot station. * * * Dividends amounting to $1,739,758.72 were paid during 1911.

From the Shattuck property were made important shipments of copper ore, carrying silver, averaging 166 tons per day up to June 1. Since then only development work was performed with one shift of about 30 men. From the East Side gold property, some siliceous gold ore was shipped to the smelter as the result of development work. The Wolverine & Arizona was also a producer of shipping ore in 1911, during which operations were carried on 362 days. The ores are oxidized and extend to a depth of 600 feet and carry about 20 cents per ton in gold. The mine is opened by a tunnel, through which 409 feet of drifting and crosscutting were performed during the year.

### COCONINO COUNTY.

The output of 3 operators in 1911 aggregated 390 tons of copper ore, averaging $4.46 per ton, as against the output made in 1910, which was valued at $5.33 per ton. The ore was produced in the Francis district and was shipped to the Humboldt smelter.

*Francis district.*—The output of 390 tons of ore, containing silver and copper, made by 3 operators, was shipped to the Humboldt smelter for flux, and was mined from shallow open cuts on the Anita and Afterthought properties. The predominating minerals are azurite and malachite.

### GILA COUNTY.

*Mine production of gold, silver, copper, and lead in Gila County, Ariz., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 1,220.45 | $25,229 | 2,433.75 | $50,310 | + 1,213.30 | + $25,081 |
| Silver.....do.... | 174,696 | 94,336 | 247,813 | 131,341 | + 73,117 | + 37,005 |
| Copper.....pounds.. | 31,330,222 | 3,978,938 | 49,226,341 | 6,153,293 | +17,896,119 | +2,174,355 |
| Lead.....do.... | 6,102 | 269 | 10,466 | 471 | + 4,364 | + 202 |
| Total..... | ..... | 4,098,772 | ..... | 6,335,415 | ..... | +2,236,643 |

The production of ore, aggregating 735,432 tons in 1911, was made by 43 producers, 1 less than reported production in 1910, when 312,057 tons of ore represented the total yield. The decrease in average value per ton from $13.13 in 1910 to $8.61 in 1911 was caused mainly by the increased output of low-grade copper ores of concentrating grade. Gold and silver values in this ore decreased from 38 cents to 25 cents per ton. Over 79 per cent, or 585,408 tons, was copper ore concentrated, which produced 66,303 tons of concentrate,

[1] Annual report for year ending Dec. 31, 1911.

containing 1,338.58 ounces of gold, 150,254 ounces of silver, and 25,925,111 pounds of copper. The copper ore of smelting grade shipped directly to smelters aggregated 122,350 tons, and contained 962.18 ounces of gold, 92,122 ounces of silver, and 22,071,341 pounds of copper. A small quantity of lead ore was shipped to the El Paso, Tex., smelter. The slag dump at the Old Dominion smelter continued to be worked, and yielded something over 1,000,000 pounds of copper in 1911.

*Banner district.*—A small shipment of oxidized iron ore, carrying large values in gold and some silver, was made in 1911 from the Standard property, from Hayden Junction to a copper plant.

*Globe district.*—The ore mined from 40 properties aggregated 735,345 tons, as against an output of 311,996 tons in 1910. The doubling of this ore output is credited to the operations of the Miami property. This mine in 1911 produced the larger part of the milling ore, which aggregated for the district 585,408 tons, yielding 66,303 tons of copper concentrates, containing $27,671 in gold, 150,254 ounces of silver, and 25,925,111 pounds of copper. The ores directly smelted aggregated 122,702 tons and contained $19,958 in gold, 97,466 ounces of silver, 22,085,130 pounds of copper, and 10,466 pounds of lead. A large tonnage of old slag was treated from the Old Dominion property, which produced over a million pounds of copper. The total output of the district was valued at $6,332,684, or an average of $8.61 per ton. Notable features of development[1] during the last two years were the depth to which secondary enrichment was found to extend along the main Old Dominion fissure, and the size of the ore bodies at a depth of even 1,600 feet from the surface. At the so-called porphyry mines, the Miami took the lead as a producer, and began producing shipping ore actively in April. At the Live Oak and the Inspiration, efforts were confined to underground development and to planning large concentrating works.

The Old Dominion mine[2] yielded from ores mined 19,195,181 pounds of fine copper, 42,050 ounces of silver, and 935.99 ounces of gold, valued in all at $2,419,946. There were milled 78,059 tons of concentrating ore, which assayed 3.5 per cent of copper.

Lessees mined 5,378 tons of iron ore for flux from the upper levels, and from the Keystone 258 tons of smelting ore and 2,219 tons of siliceous ore for converters. About 19,000 tons of smelting grade ore were obtained by working over old stopes between the second and tenth levels. * * * The ore bodies west of the west fault produced during the year 48,000 tons of ore, all oxidized and of smelting grade, 20,000 tons of which came from the eleventh level and the remainder from the twelfth and thirteenth levels in about equal proportions. * * * Development in the west end of the mine has uncovered practically a continuous ore body on the Old Dominion fault from the ninth to the fourteenth levels, which is the deepest level in which development has been carried on extensively enough to reach the probable location of the vein, and in the immediate levels above the fourteenth the extent of the ore body in any direction has not been determined. The ore, however, is similar in character and grade to that found in the levels above. The remainder of the year's production, with the exception of a small quantity taken from the "Kirkey" vein, came from the Old Dominion vein east of the west fault. The ore is sulphide in character, principal copper values occurring as chalcocite, of both direct smelting and concentrating grades. * * * The deepest workings are only 1,200 feet. * * * Dividends amounting to $486,000 were paid in 1911, making a total of $1,822,500 since July 31, 1907.

[1] Douglas, James, Eng. and Min. Jour., Jan. 6, 1912, p. 13.
[2] Annual report for year ending Dec. 31, 1911.

Ore aggregating 110,578 tons mined from the United Globe [1] property contained 8,525,433 pounds of copper, 111,459 ounces of silver, and 875 ounces of gold. Shipments were made to the Old Dominion, Copper Queen, Calumet & Arizona, and El Paso smelters.

The ores of the United Globe mines consist principally of two classes: Ores so high in silica that they can not be profitably smelted locally, but are in demand at the smelting works of the Southwest for converter linings or as a flux to a basic charge; and granular sulphides, much of which passes through the concentrator before reaching the furnaces. The quantity of sulphides developed is sufficient to meet local demands, but it is more profitable to secure favorable freight rates for the highly siliceous ores by drawing sulphides from Bisbee as return freight. The probable preponderance of siliceous ores in the extensive unexplored eastern sections of the United Globe property on the Old Dominion vein suggests the advisability of considering some leaching method. In that case, should all the siliceous ores be utilized on the spot, the low-grade sulphide ores already exposed would meet the requirements of the furnace plant. * * * Dividends were paid from 1905 to 1907 amounting to $379,500.

The ore extracted by stoping from the Miami copper[2] mine was taken largely from the eastern part of the mine, above the 370-foot level. The work was started by cutting out under the capping by means of square sets and has progressed by a combination of square-setting and sublevel caving which has been very satisfactory.

In the west and northwest parts of the mine it is planned to extract the ore by means of shrinkage stope rooms. Five of these rooms have been started and their working has been most satisfactory. * * * Milling of the ore was started in the month of March, and the plant has operated continuously since that time, handling a gradually increased tonnage. The estimated capacity of 2,000 tons per day for the entire plant has been greatly exceeded, the amount treated per section having been increased to about 500 tons per day. The operation of the plant from a mechanical and a metallurgical standpoint has been very gratifying. The results of milling operations for the year are as follows:

*Operation of Miami copper mine, Arizona, in 1911.*

| | Quantity. | Average per ton of copper. |
|---|---|---|
| | | *Per cent.* |
| Ore milled.....tons.. | 445,036 | 2.48 |
| Concentrate produced.....do.... | 20,065 | 40.36 |
| Copper in concentrate.....pounds.. | 16,195,561 | ..... |
| Copper recovered per ton ore.....do.... | 36.39 | ..... |
| Mill extraction.....per cent.. | 73.37 | ..... |

From the concentrate shipped to Cananea, Mexico, the net return of refined copper amounted to 15,385,783 pounds. Based on the net production, the cost of copper in concentrate on board cars in Miami was as follows:

*Cost of copper in concentrate f. o. b. cars at Miami, Ariz., in 1911.*

| | Per ton ore. | Per pound of copper. |
|---|---|---|
| Mining..... | $1.2134 | $0.03500 |
| Milling..... | .6274 | .01810 |
| General..... | .1706 | .00492 |
| Total..... | 2.0114 | .05802 |

[1] Annual report of Old Dominion Copper Mining & Smelting Co. for year ending Dec. 31, 1911.
[2] Annual report for year ending Dec. 31, 1911.

Prospecting the unexplored territory adjacent to the ore body by means of churn drills in progress during the early part of the year was discontinued. * * * Hole No. 37, drilled in the bottom of No. 3 shaft located on the Red Spring mining claim, disclosed ore of commercial grade and drilling has just been resumed to complete the examination of this part of the company's ground. Underground, the development drifts and raises have confirmed the churn drill work in the northwest part of the ore body and above the 420-foot level have added slightly to the ore developed. After allowing for the ore extracted during the year, the reserves are estimated to amount to 18,232,000 tons, averaging 2.58 per cent of copper.

The mineralization of the Inspiration[1] ore deposits consists of a uniform dissemination of copper minerals through the mass of the silicified rock, and of small seams and veinlets running in all directions.

The genesis of the ore deposit is similar to that of the disseminated copper deposits of Bingham (Utah), Ely (Nev.), and Ray (Ariz.). The surface is much stained by iron and the rock shows small cavities or vugs which were formerly filled with sulphide minerals. For a depth varying from 50 to 800 feet, and averaging 354 feet for the Inspiration section and 435 feet for the Live Oak section, the sulphides have been oxidized and leached out. This oxidized zone is known as capping. The copper was redeposited at a lower horizon in the form of chalcocite, producing an enriched zone which forms the commercial ore body. This zone averages 142 feet in thickness for the Inspiration section, and 114 feet for the Live Oak section, and is underlain by the primary ore zone, carrying copper in the form of cupriferous pyrite.

Over 40,000 feet, or approximately 7½ miles, of underground development work has been driven on the property, divided as follows:

*Underground development work in Inspiration mine in Arizona, in 1911.*

| | | |
|---|---|---|
| Shafts | feet | 3,220 |
| Raises | do | 4,037 |
| Drifts and tunnels | do | 32,761 |

This work has exposed the main Inspiration ore body for a length of 3,500 feet and maximum width of 1,600 feet. * * * Churn drill holes have been located regularly at the corners of squares, with sides 200 feet long; 226 holes have been drilled, having a total footage of 120,834 feet, and an average depth of 535 feet. * * *

The ore reserves have been divided into two classes, namely, developed and partially developed. All developed ore is bounded either by drill holes or underground workings, not in excess of 200 feet apart. In areas not yet completely drilled the ore has been classed as partially developed. * * * The ore reserves of the Inspiration Consolidated are estimated to be as follows:

*Ore reserves of the Inspiration Consolidated mine, Arizona.*

| | Quantity. | Average percentage of copper. |
|---|---|---|
| | *Short tons.* | |
| Developed | 42,050,000 | 2.01 |
| Partially developed | 2,950,000 | 1.85 |
| Grand total | 45,000,000 | 2.00 |

Extension of the Live Oak ore body to the southwest and extensions of the Inspiration ore body may be expected ultimately to add considerable to the ore reserves, but these possibilities have not been included in the present estimate. The total area developed and partially developed is 98.1 acres, and the average number of tons of ore per acre is 458,700 tons.

[1] Statement to stockholders, Apr. 22, 1912.

## GRAHAM COUNTY.

Only one property in Graham County was productive in 1911. The ore shipped contained lead and small quantities of gold, silver, and copper, which was mined from the Arivaipa district.

## GREENLEE COUNTY.

*Mine production of gold, silver, copper, and lead in Greenlee County, Ariz., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 2,331.24 | $48,191 | 1,525.79 | $31,541 | − 805.45 | −$16,650 |
| Silver.....do.... | 147,060 | 79,413 | 104,429 | 55,347 | − 42,631 | − 24,066 |
| Copper.....pounds.. | 72,878,094 | 9,255,518 | 70,926,330 | 8,865,791 | −1,951,764 | −389,727 |
| Lead.....do.... | 31,576 | 1,389 | 30,734 | 1,383 | − 842 | − 6 |
| Total..... | ..... | 9,384,511 | ..... | 8,954,062 | ..... | −430,449 |

Twenty-three deep mines in Greenlee County, from which production was reported in 1911, yielded 1,551,220 tons of ore—a decrease of 9,947 tons from the production of 1910, made by the same number of producers. The total average value of the ore decreased from $6.01 to $5.77 per ton, and the gold and silver average value from 8 cents to 6 cents per ton. Copper ores predominated and aggregated 1,545,998 tons in 1911. In addition to this, 239 tons of lead ore were shipped for treatment to smelters outside of the State. Over 85 per cent, or 1,323,447 tons of ore, was treated at concentration mills, yielding 202,000 tons of concentrate, which contained 195.99 ounces of gold, 12,443 ounces of silver, and 53,357,822 pounds of copper, in all valued at $6,680,375, or an average of $33.07 per ton. The ores directly smelted aggregated 227,747 tons and contained 1,300.61 ounces of gold, 91,972 ounces of silver, 17,568,508 pounds of copper, and 30,734 pounds of lead, having a total value of $2,273,078, or an average of $9.98 per ton. The average value of smelting ores in 1910, when 253,279 tons were produced, was $10.87 per ton. No gold was reported in 1911 by placer operators, although it is known that several tests were made with experimental equipment. The results are probably included in the deep-mine operations. The most promising development [1] was the discovery of profitable secondary ores at considerably greater depth than was theretofore assigned as the limit in depth of the altered zone. These deeper ores occur along certain fault planes in the Humboldt mine of the Arizona Copper Co. and the West Yankie mine of the Detroit Copper Co., and encourage the hope that the district may possess resources heretofore unsuspected.

From the Detroit copper mines [2] there was a yield of 517,087 tons of smelting and concentrating ore, which produced 22,704,398 pounds of copper, or an average of 45.9 pounds per ton. The larger part of the ore, aggregating 501,093 tons, and assaying 2.87 per cent of

[1] Douglas, James, Eng. and Min. Jour., Jan. 6, 1912, p. 12.
[2] Annual report Phelps, Dodge & Co., for year ending Dec. 31, 1911.

copper, was concentrated; 7,904 tons were smelting ore, assaying 16.85 per cent of copper; and 7,745 tons were siliceous ore, assaying 5.75 per cent of copper, and used for converter lining. The ratio of concentration of the milling ore was 7.57 tons into 1 ton of concentrate, which aggregated 66,012 tons, assaying 15.87 per cent of copper, representing a mill saving of 73.05 per cent.

The prospecting for the year, measured by the tonnage of new ore developed, has not been encouraging. The ore on the Concentrator fault at the seventh level of the old Yankie, found at a depth of 100 feet below any previously known ore in that mine, promised more at the beginning of last year than has been proven by the year's development. Nevertheless, some 67,000 tons of 4 per cent ore was developed by the year's work here, lying in a body 400 feet long, from 40 to 70 feet wide, and apparently having a vertical dimension of only 35 feet. * * * Near the close of the year two promising discoveries were made. The first of these is a crosscut to the north through the Concentrator fault and beyond, in the old Yankie claim, where 50 feet of 2.5 per cent ore has been cut. The second case is in the favorable showing in the west drift on the 600-foot level of the Dad Wright shaft at Santa Rosa. Neither of these developments has progressed far enough to warrant any statement as to the quantities of ore.

During the year ending August 31, 1911, there was extracted from the Shannon [1] mines 263,975 tons of ore, as against 311,456 tons the previous year.

The output of fine copper was 14,944,933 pounds, and from custom ores only 233,169 pounds, or a total of 15,168,102 pounds. * * * The new development work in the lower levels, both at east end and west end of the Shannon mine, opened up considerable smelting and concentrating ores. * * * Part of the development work was directed toward opening up the low-grade semioxidized ores of which there is a very large tonnage, averaging from 2 to 2½ per cent of copper. These ores have been partly worked in the past by means of open cuts, and the better grades, running from 5 to 6 per cent copper, were shipped to the smelter; the remainder, or the lower-grade ores, were either thrown away as waste or used for filling stopes. This procedure entailed the mining of 4 to 6 tons of low-grade ores for every ton of selected ore shipped, and, naturally, was expensive. There is no known method of treating these ores, as a whole, profitably, at the present time, but the problem will undoubtedly be solved. It is estimated that there is not less than 1,000,000 tons of these ores in the mines, with every probability of there being a much larger tonnage. * * * Experiments on the low-grade semioxidized ores are at present under way on a large scale, but as the process requires several months for proper treatment exact data can not be given at this time.

The Arizona Copper Co [2] mines yielded 34,569,019 pounds of Bessemer copper, as compared with 32,161,205 pounds the previous year, the largest output since the company began operations.

The total ores mined aggregated 744,746 tons, and the yield as indicated by smelter returns averaging 46.4 pounds of copper per ton. Ninety-four per cent of the total ores mined were concentrating ores, the remainder—6 per cent—being direct smelting ores (including pyrites for acid plant and siliceous ores for converter lining). Of the total copper produced, 82 per cent came from sulphide ores and 18 per cent from oxide ores. At the concentrator 582,335 dry tons of sulphide concentrating ores were treated, and the average ratio of concentration was 5.6 tons of ore into 1 ton of concentrates. Concentrator No. 6 was enlarged from 900 tons to 1,500 tons per day capacity, but the work was not sufficiently advanced to affect the results for the year. The oxide concentrator handled 104,754 dry tons of ore, the tailings from which, amounting to 90,526 dry tons, were treated in the leacher. From the oxide ores 11.5 per cent of the total copper was produced. The sulphuric acid plant supplied 3,778.675 tons of acid, which was used for leaching the ores. In the smelting department 3.3 furnaces, on an average, were in blast and the total ore and concentrates smelted aggregated 153,991 tons. With fluxes and by-products resmelted the amount was 230,833 tons. The average yield of copper from ores and concentrates was 11.22 per cent. The crude smelting ores were from the Humboldt, Clay, Petaluma, and some outside claims of the company; the siliceous ore used for converter lining was mined from the Humboldt

[1] Annual report for year ending Aug. 31, 1911.
[2] Annual report of Arizona Copper Co., for the year ending Sept. 30, 1911.

and Yavapai claims, the latter furnishing 1,885 tons of iron pyrite containing 2.87 per cent of copper. Pyrite was also mined from the Joy iron vein. All of the concentrating sulphide and carbonate ores were mined from the Humboldt, Clay, Petaluma, Carasco, Yavapai, Longfellow North Extension, Metcalf, King, Mammoth, and Coronado mines.

MARICOPA COUNTY.

The production of 19,252 tons of dry or siliceous ore and 4 tons of copper ore, the yield of 4 producing mines in 1911, had a total value of $98,269. The larger part of the values in the siliceous ore was extracted by the amalgamation process and the treatment of tailings by cyanidation, all of which yielded bullion valued at $96,838. In addition to this production, there were 10 tons of crude smelting ore, which yielded 17.80 ounces of gold, 16 ounces of silver, and 729 pounds of copper, valued in all at $467, or an average of $46.70 per ton. The placer production was $962 in gold and 5 ounces of silver.

*Cave Creek district.*—Operations in Cave Creek district were less than usual. Only a small amount of bullion was produced, which was probably the clean-up of the milling plant, as the mill in the district was not reported in operation.

*Eagle Eye district.*—The station and post office of this district is Aguila, on the Santa Fe, Prescott & Phoenix Railroad. A trial shipment of copper ore, carrying a small quantity of gold and no silver, was made from the Aguila and Yalu claims.

*Vulture district.*—Ore produced from the Vulture mine is described as gold quartz with some pyrite and galena. This ore was treated in a 20-stamp amalgamation and cyanide plant of a daily capacity of 125 tons. In addition to this, a lot of old tailings were retreated by cyanidation. The property is opened by 2 incline shafts, 600 feet and 800 feet, respectively. The east incline shaft was sunk 400 feet and the mine developed on the 750-foot and 850-foot levels in 1911.

MOHAVE COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Mohave County, Ariz., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 55,390.44 | $1,145,022 | 74,868.20 | $1,547,663 | +19,477.76 | +$402,641 |
| Silver.....do.... | 112,445 | 60,720 | 143,969 | 76,304 | + 31,524 | + 15,584 |
| Copper.....pounds.. | 529,753 | 67,279 | 244,378 | 30,547 | − 285,375 | − 36,732 |
| Lead.....do.... | 740,091 | 32,564 | 2,591,589 | 116,622 | +1,851,498 | + 84,058 |
| Zinc.....do.... | 5,474,046 | 295,598 | 4,476,552 | 255,164 | − 997,494 | − 40,434 |
| Total..... | ..... | 1,601,183 | ..... | 2,026,300 | ..... | + 425,117 |

The production of 140,402 tons of ore by 47 mine operators in Mohave County in 1911 is an increase of 41,119 tons of ore and of 7 in the number of operators. The total average value per ton decreased from $16.12 in 1910 to $14.43 in 1911, and the gold and silver average value from $12.14 to $11.57. Nearly all of the ore, or 107,327 tons, was treated by cyanidation and amalgamation processes. The largest yield was made from the former process, which

produced 70,498.19 ounces of gold and 33,759 ounces of silver shipped as bullion. The ore amalgamated yielded 698.20 ounces of gold and 400 ounces of silver. The total value of all the bullion was $1,489,864. Concentrating ore aggregating 25,184 tons yielded 7,419 tons of concentrate, containing 2,440.15 ounces of gold, 72,852 ounces of silver, 19,772 pounds of copper, 2,337,663 pounds of lead, and 3,084,612 pounds of zinc, valued in all at $372,543, or an average of $50.21 per ton. Crude ores of smelting grade shipped directly to the smelters aggregated 3,413 tons, containing 1,231.66 ounces of gold, 36,958 ounces of silver, 224,606 pounds of copper, 253,926 pounds of lead, and 1,391,940 pounds of zinc, valued in all at $163,893, or an average of $48.02 per ton. The largest part of the ores mined, aggregating 112,541 tons, containing 71,694.40 ounces of gold and 49,681 ounces of silver, were siliceous in character. The next largest tonnage was for zinc ores, which aggregated 15,980 tons. There were also produced 10,756 tons of lead-zinc ores, 344 tons of copper ore, and 781 tons of lead ore. The zinc and lead-zinc ores were shipped to zinc plants outside of the State, and the lead and copper ores to Needles, Cal., and Humboldt, Ariz. Part of the zinc ore was treated at the concentration plant connected with the Needles smelter, where a wet mill and an electrostatic zinc separating plant is in use. Some of the accumulated product from the wet concentration mill produced in 1910 was treated at the electrostatic plant and the figures for the concentrate are included in this report.

*Bentley district.*—The Grand Gulch mine was the only producer in this district in 1911. The ore that was shipped contained copper and silver, averaging $78.90 per ton. It is expected that the railroad branch from Moapa to St. Thomas, which is under construction, will be completed in April, 1913, thus shortening the haul 26 miles.

*Cedar Valley district.*—Ore containing lead and considerable values in gold and silver with a little copper, was shipped from the district in 1911 by 2 operators.

*Cottonwood district.*—The Walkover mine, which is opened by a shaft 50 feet deep, produced siliceous ore which was treated in an arrastre, producing rich gold and silver bullion, which was shipped to the mint.

*Gold Basin district.*—All of the ore produced from 3 properties was produced at gold and silver mills. The aggregate yield was 431 tons. The principal producer was the Cyclopic mine, opened by shafts and shallow cuts and yielding an oxidized ore with siliceous gangue, which is said to extend to a depth of 75 feet. The property is equipped with a 20-ton Ellspass mill and cyanide plant.

*Greenwood district.*—A small production was recovered by an arrastre, which treated ore from one of the claims in the district.

*Owens district.*—One lot of sulphide ore with siliceous gangue was shipped from the McCracken mine to a lead plant in 1911, and carried lead and small quantities of gold, silver, and copper. There was no development work reported on the property and the ore shipped was taken out by lessees. It is claimed that the haul to the railroad is too long for profit. The property is opened by a vertical shaft 550 feet deep and 6,000 feet of drifts. The ore is oxidized to a depth of 300 feet, but occasional bunches of galena are found on the surface.

*San Francisco district.*—Ore was produced from 8 mining properties aggregating 110,699 tons, which yielded $1,458,639 in gold and 33,834 ounces of silver, with a total value of $1,476,571, or an average of $13.34 per ton. All but a trial lot of ore of 8 tons, which was shipped to the smelter, was treated at mills equipped with the cyanidation process. The Gold Crown property yielded gold and silver bullion in the operation of its 60-ton cyanide plant, which is equipped with a primary crusher, rolls, ball and pebble mill, and cyanide tanks. It is reported that the operation of the mill was only successful during the latter part of the year. The property is opened by tunnels and adits aggregating 3,000 feet in length. About 1,100 feet of this work was performed in 1911. The Gold Road property is opened by three incline shafts 700 feet deep and by 10,000 feet of drifts. There were 2,000 feet of drifts and 200 feet of shaft work performed in 1911. The cyanide plant was treating 250 tons of ore per day, crushed by stamps and tube mills with direct cyaniding of ore and filtration of slimes. The plant was operated the entire year and no change was made, except in the ownership of the property, which was transferred to the United States Smelting & Refining Co. or its allied interests. The Ruth property is equipped with a 50-ton cyanide plant, and although it produced some gold and silver bullion in 1911 its operations were not reported to be very important. An important tonnage of siliceous gold and silver ore and old tailings was treated in the 20-stamp mill and cyanide plant of the Tom Reed mine. The mill has a capacity of about 125 tons of ore per day and is reported to have been practically in continuous operation. The mine is opened to a depth of 850 feet by a vertical shaft and the drifts approximate 9,000 feet.

From the Tom Reed [1] mine there was produced and milled during the company's fiscal year 39,447 tons of ore, yielding gold and silver bullion, recovered by the cyanide treatment, valued at $802,598.71, and exceeding the record for 1910 by $208,485.53 in value, and in quantity of ore mined by 25,157 tons. In addition to ore from the mine, 4,477 tons of tailings were reworked and yielded $32,449. The mine is opened to the eighth level. The vein was encountered on this level at the usual distance from the shaft, and in driving into the footwall a heavy flow of water prevented further work at the time. The cost of mining during the year amounted to $3.27 per ton, of milling to $1.46 per ton, and of cyaniding to $1.42 per ton. Total dividends aggregating $591,296.28 have been paid.

The Gold Road mine [2] is located about 24 miles northwest of Kingman, which is also the center of the operations of the Needles Mining & Smelting Co.

The Gold Road mine was purchased during the year. It has a large reserve of ore carrying good values in gold and is equipped with a 40-stamp mill. The management of the property was taken over by the United States Co. in the month of July, 1911. Efforts since then have been directed mainly toward opening up the mine in depth as well as on the strike and to improve the methods of mining and milling with a view to lowering costs. Considerable progress was made. The ore reserves were greatly increased, and marked economies in the extraction and treatment of the ore were achieved.

[1] Annual report for year ending Apr. 1, 1912.
[2] Annual report United States Smelting, Refining & Mining Co. for year ending Dec. 31, 1911.

*Wallapai district.*—The output of this district includes the production of the mines at Union Basin, Cerbat, Chloride, Mineral Park, and Stockton Hill. The bulk of the ore was mined from the Golconda mine at Union Basin. Important tonnages were also loaded at Berry, Kingman, and Chloride, from the Banner, Champion, and Tennessee mines controlled by the Needles Smelting Co. The total output aggregated 28,672 tons, which contained $79,602 in gold, 109,304 ounces of silver, 27,652 pounds of copper, 2,564,673 pounds of lead, and 4,476,552 pounds of zinc, valued in all at $511,565, or an average of $17.84 per ton. The Union Basin Mining Co. worked the Golconda, Tub, Prosperity, and Blackfoot claims, all contiguous and practically one mine. The bulk of the sulphide ore produced was treated in the 100-ton concentration mill, which is equipped with Blake crusher, rolls, jigs, and Wilfley tables. The middlings were reground by a Huntington mill. The crude zinc ore shipped averaged 45 per cent of zinc. The mine is opened by an incline shaft 400 feet deep and a tunnel 1,800 feet long. The shaft was sunk 80 feet and the tunnel driven 700 feet in 1911. Lead concentrates, carrying considerable values in gold and silver with a little copper, were loaded for shipment at Kingman from the C. O. D. property in 1911. The sulphide ore in a siliceous gangue was treated in a 40-ton concentrating mill in which the crushing is done by rolls and the ore is concentrated over Bartlett tables. The property is opened by a vertical shaft 400 feet deep and has about 2,000 feet of drifts. The Badger-Hercules group has had a large amount of work done on the property, exposing a large tonnage of smelting and concentrating ores, the principal values being in silver and lead. The Hercules group carries principally gold ore, for which it is reported assays have been received as high as 4 ounces per ton. Shipments of copper sulphide ore with siliceous gangue, carrying gold and silver values, were made from the Keystone mine. The property is opened by a vertical shaft 260 feet deep and has 1,200 feet of drifts. The 5-stamp amalgamation mill was not operated in 1911. The Oro Plata mine produced a sulphide ore with siliceous gangue, which was concentrated in a mill equipped with 2 stamps of the California type and a Nissen mill and 2 Wilfley tables for concentration. The property is opened by vertical and incline shaft 280 feet deep. For the last seven years it has been under water, which was lowered to the 180-foot level in 1911. The mill was started in October, producing concentrates containing important values in gold with some silver, copper, and lead. The Rainbow property, near Chloride, produced sulphide lead ore with siliceous gangue, carrying important values in gold and silver, and small quantities of copper. The oxidized ores extend to a depth of 100 feet. The vertical shaft has been sunk to a total depth of 440 feet. The company operating the property equipped it with an aerial tramway in 1911. Lead sulphide ore carrying 64 per cent lead and 12 ounces of silver per ton was taken out of the St. Louis property, near Cerbat, during assessment work. Development was carried on through a tunnel, at the end of which a winze has been sunk 50 feet.

*Weaver district.*—The Gold Bug property yielded a trial lot of oxidized quartz ore, but no work was performed on the property in 1911. It is opened by a vertical shaft 512 feet deep.

## PIMA COUNTY.

In all only 8,210 tons of ore were mined in Pima County in 1911, a decrease of 169,465 tons from the output of 1910, and in the number of properties worked there was a decrease from 25 to 19 in 1911. The average value per ton of the ore increased from $4.80 to $16.24 and the gold and silver value from 34 cents to $1.12. The deep mine production was 86.16 ounces of gold, 13,936 ounces of silver, 984,737 pounds of copper, and 23,506 pounds of lead, having a value of $133,317. Only 29 tons of the ore were treated by the amalgamation process, having an average recovery of $15.37 per ton for the gold and silver. The largest part of the production, or 7,581 tons, was shipped directly to smelters and yielded 54.52 ounces of gold, 13,525 ounces of silver, 874,697 pounds of copper, and 23,506 pounds of lead, valued in all at $118,690, or an average of $15.66 per ton. By the concentration process 600 tons of ore were milled, producing 131 tons of concentrate, which contained 10.48 ounces of gold, 393 ounces of silver, and 110,040 pounds of copper, valued in all at $14,181, or an average of $108.25 per ton. The production of gold and silver bullion from placers was $3,843 in gold and 29 ounces of silver.

*Ajo district.*—The Quien Sabe and Ajo mines were productive of an important tonnage of ore and concentrates, carrying gold and silver values, which were shipped to the Douglas smelter. Much prospecting has been performed in the district.

In the latter part of 1911 an option was taken by the Calumet & Arizona Mining Co.[1] on the property of the New Cornelia Copper Co. and on several adjoining claims. In all there are 22 claims under option.

On the surface there is a very large showing of mineralized, brilliantly copper stained monzonite. From narrow high-grade veins in the outlying parts of the district ore has been shipped spasmodically for nearly a hundred years. The few holes which were sunk in the heart of the mineralized area developed from 30 to 100 feet of low-grade siliceous carbonate ore, with "disseminated" ore of good grade below it. This area is now being drilled systematically with the hope of finding a large body of concentrating ore, which may be mined by an open pit.

*Arivaca district.*—Four producers reported the shipment of gold and silver ore, aggregating 31 tons, which contained $608 in gold, 190 ounces of silver, 77 pounds of copper, and 334 pounds of lead, in all valued at $733, or an average of $23.65 per ton.

*Baboquivari district.*—Copper ore carrying gold and silver values, taken out in development work on 3 properties, aggregated 42 tons, containing $124 in gold, 885 ounces of silver, and 6,610 pounds of copper, valued in all at $1,419, or an average of $33.79 per ton. The Papago Chief, Gold Bullion, and Sterling properties were producers.

*Empire district.*—The State of Maine property was productive of lead carbonate ore with a siliceous gangue, of which a trial shipment was made from Pantano. The property is opened by a vertical shaft 130 feet deep.

*Helvetia district.*—Two properties in the district yielded trial lots of copper ore, one of the deposits producing some lead. Operations of the Copper World property, belonging to the Helvetia Copper Co., stopped in April.

[1] Annual report for year ending Dec. 31, 1911.

*Pima district.*—The output of 5 producers aggregated a yield of 7,329 tons of ore, containing $103 in gold, 10,771 ounces of silver, 685,879 pounds of copper, and 17,616 pounds of lead, valued in all at $92,340, or an average of $12.60 per ton. The largest output was made from the Twin Butte mine, which yielded copper ore carrying some silver. The producers next in order of importance were the Tiger, Crown King, and Esperanza properties of the Chesterfield Copper Co., which produced sulphide lead ore shipped to El Paso, Tex. The storage is reported of silver-copper ore, which will be treated by the Pioneer Smelting Co. at Sahuarito, a station on the new Tucson-Nogales branch of the Southern Pacific Railroad. The Chesterfield property has been opened by a new incline shaft, which at the present time is 400 feet deep.

PINAL COUNTY.

Twenty-one deep mines in Pinal County yielded 686,212 tons of ore in 1911, against 15 mines yielding only 239 tons in 1910. This large increase in tonnage is due to the concentration of low-grade copper ores of the Ray mine, which was also responsible for the average value decreasing from $39.30 to $2.93 per ton and the average value of the gold and silver content from $30.85 to $0.05 per ton. Output of concentrating ores was 682,120 tons, which produced 35,705 tons of concentrate, containing 8 ounces of gold, 21,355 ounces of silver, 15,736,271 pounds of copper, and 6,643 pounds of lead, valued in all at $1,978,817, or an average of $55.42 per ton. The crude smelting ore shipped directly to smelters aggregated 242 tons, which included some rich copper sulphide ore, lead ore, and copper-lead ore, containing 29 ounces of gold, 8,361 ounces of silver, 75,552 pounds of copper, and 81,311 pounds of lead, valued in all at $18,134, or an average of $74.93 per ton. The treatment of 3,795 tons of ore by the amalgamation process produced 666.96 ounces of gold and 192 ounces of silver, valued at $13,889. The gold and silver bullion from placers contained $1,161 in gold and 6 ounces of silver.

*Bunker Hill district.*—During assessment work on the Cumberland property some lead sulphide ore, carrying values in gold, silver, and copper, was taken out and shipped. The mine is opened by a shaft 75 feet deep and has a 350-foot adit.

*Casa Grande district.*—Seven deep mines yielded 101 tons of ore, containing $610 in gold, 1,730 ounces of silver, 2,133 pounds of copper, and 12,132 pounds of lead, valued in all at $2,340, or an average of $23.17 per ton. The principal producer was the Turning Point mine, yielding a lead ore carrying gold and silver values, which was treated in a 10-stamp amalgamation and concentration mill, yielding concentrates and bullion. Principally testing work was performed in 1911, and the owner of the property reported better success in the saving of the values of the ore with the cyanide process, with which the mill will be equipped. The mine is opened by a 325-foot incline shaft.

*Goldfield district.*—This district extends into Maricopa County, but the producing mines are reported to be in Pinal County. The producers, the Mammoth and the Goldfield, made an output of bullion from test runs on ore taken from the properties in 1911. The 10-stamp mill on the Mammoth property is old and reported to be practically worthless. It is stated that the ore can be successfully treated

by the amalgamation and cyanidation processes. The greatest depth obtained by the shaft on the Mammoth mine is 445 feet.

*Mineral Creek or Ray district.*—The gigantic developments at the Ray mine are carried on through vertical shafts and drifts, and the crude ore produced is given a preliminary dry grinding and is concentrated wet in a mill of a capacity of 8,000 tons daily. The ore treated is a sulphide with siliceous gangue. The oxidation varies from 50 to 400 feet in depth. Active production began in April, 1911. The total area of mining lands of the Ray Consolidated Mining Co.[1] approximated 1,950 acres, and, with the exception of a few unimportant claims, the entire group is patented.

* * * As the drilling development now stands the total tonnage calculated is 77,314,470 tons, averaging 2.17 per cent copper. Of this quantity, 64,700,000 tons, having an average grade of 2.16 per cent copper, is classed as fully developed, the remainder being classed as partially developed and having an average grade of 2.23 per cent copper. As has been explained in previous reports, the ore classed as fully developed is in deposits that have been drilled regularly and completely in 200-foot squares, and the partially developed exists in areas that in places have not been drilled at intervals of greater frequency than 400 feet. * * * The average thickness of capping, or overburden, is 252 feet, and the average thickness of ore 101 feet. * * * In the area represented by the holes entering into the calculation of ore reserves the average thickness of ore is 121 feet. Of the total tonnage above stated, about 30,000,000 tons exist in what is known as the east section, or in the vicinity of the No. 1 shaft, the remainder, about 47,000,000 tons, lying in the west section. * * * The total amount of underground development work existing on January 1, 1912, was 158,898 feet, or a little over 30 miles. This is an increase for the 18 months of 122,000 feet, or at a rate of nearly 7,000 feet per month, and approximately this rate is being maintained at the present time. The areas adjacent to both shafts have been, and are now being, developed on two principal levels, although in both cases auxiliary levels are being worked above the No. 1 or main upper levels. * * * The system of mining employed, which is commonly known as the "shrinkage stope" system, has been applied to sufficiently large areas in two portions of the eastern section to demonstrate its adaptability, both as to economy and safety. * * * No mining was done, except in the way of development work, until late in March, 1911, when the first section of the mill at Hayden was started. During the remainder of the year the mine produced approximately 700,000 tons of ore. * * * The actual cost for the period, including coarse crushing of the ore as well as all general and fixed charges, was 81.6 cents per ton. * * * The first section of the mill was started about the middle of March, 1911, but did not operate continuously until after April 1. Another section was started in April, and since that time three additional sections have been completed, although it has not been necessary to operate more than four of them at any one time to accommodate all the tonnage available. It was found desirable immediately after beginning operations to modify somewhat the arrangement of machinery and distribution of products in order to get satisfactory results. * * * The total ore treated for the year was 681,519 tons, of an average grade of 1.83 per cent, resulting in a gross output of copper contained in concentrates of 15,721,520 pounds and corresponding to an average extraction for the entire period of 63.1 per cent. * * * The average assay of concentrates produced for the period was 22.4 per cent. * * * The Ray Consolidated sold to the American Smelting & Refining Co. its smelter which was building at Hayden to treat the concentrates from the mill. The smelting rate which was made by the latter company was so low that it was to Ray's advantage to turn over their plant to that company. * * * The Ray & Gila Valley Railroad, which is owned by the Ray Consolidated Co., connects the town of Ray with Kelvin and Ray Junction.

*Old Hat district.*—Four deep mines and 1 placer were productive in 1911. The largest part of the tonnage, or 3,055 tons, including 55 tons of old tailings, was treated at gold and silver mills, and 33 tons of lead ore were shipped directly to the smelters. The total value of the district output aggregated $10,840. The Mohawk mine produced the largest tonnage of ore, which was treated in the 30-

[1] Report for 18 months ending Dec. 31, 1911.

stamp amalgamation mill, the power for which is furnished by crude-oil burners and oil-storage tanks. The mine is opened by a vertical shaft 525 feet deep and has 4,000 feet of drifts. The Seneca and Lost Horse groups were operated, producing a silver-lead ore which is considerably oxidized.

*Owl Head district.*—The Cloud Burst property was operated until in August. Sinking and drifting were carried on and new machinery was installed. A small lot of oxidized copper ore was shipped. The mine is opened by a vertical shaft 300 feet deep, to the bottom of which the oxidized ores extend.

*Pioneer district.*—Two mines in this district produced copper and lead ores in 1911. The Blackfoot and the Silver Queen mines, operated by the Magma Copper Co., yielded a sulphide copper ore carrying values in gold and silver. The mine is opened by a tunnel 556 feet long, giving surface connections with the shaft, which is 400 feet deep.

*Riverside district.*—One mine yielded a small tonnage of ore carrying sulphide of iron in quartz containing gold, which was extracted by an arrastre. The shaft on the property is 65 feet deep and there are 200 feet of drifts. The ores are siliceous in character and the oxidization extends to the bottom of the shaft.

### SANTA CRUZ COUNTY.

The ore produced by 17 producers in 1911, against 21 producers in 1910, aggregated 1,078 tons, which is 285 tons more than was produced in 1910. The total average yield of the ore per ton was valued at $30.89 in 1911, against $72.39 in 1910, and the average value in gold and silver per ton was $7.72, against $58.92 in 1910. The larger part, or 878 tons, was shipped crude to smelters and contained 40.81 ounces of gold, 12,687 ounces of silver, 122,642 pounds of copper, 193,000 pounds of lead, and 16,844 pounds of zinc, valued in all at $32,542, or an average of $37.06 per ton. Concentrates were produced at one mill, where the ores were first treated by the amalgamation process. In all, 200 tons were treated by amalgamation, yielding gold and silver bullion having an average recovery value of $3 per ton. The concentrates, containing gold, silver, and copper, had an average value of $53 per ton. Bullion from placers contained $619 in gold and 5 ounces of silver.

*Oro Blanco district.*—One deep mine and two placer properties were productive of gold bullion and some ore carrying a little copper, shipped from the Arizona-Ophir mine, whose operators made some tests in its 30-stamp amalgamation mill preliminary to putting in the cyanide process.

*Palmetto district.*—Extensive mine operations were performed on the Three R group. The ore produced from the property in 1911 carried principally copper, with some lead and silver.

*Patagonia district.*—Three mines produced 52 tons of ore carrying $145 in gold, 595 ounces of silver, 18,915 pounds of copper, and 1,483 pounds of lead, valued in all at $2,891, or an average of $55.60 per ton. Copper sulphide ore, carrying gold and silver values, was shipped from the Collicello property, which is opened by a shaft 70 feet deep. The ore from this property represented the principal part of the output of the district.

*Tyndall district.*—Five deep mines yielded 428 tons of ore, carrying $103 in gold, 4,069 ounces of silver, 44,135 pounds of copper, 180,971 pounds of lead, and 16,844 pounds of zinc, valued in all at $16,881, or an average of $39.44 per ton. The principal part of the ore tonnage produced was shipped from the Alto property and consisted of lead, silver, and copper sulphides which occur at the surface. The mine is opened by three shafts from 120 to 300 feet deep and a tunnel 1,800 feet long. The property was closed in September. The Sheehey mine, near Tubac, yielded carbonate and sulphide ore, carrying gold, silver, copper, lead, and zinc. A lot of zinc ore carrying lead, silver, and a little iron was shipped to a Colorado zinc plant, and part of the production of lead ore was forwarded to El Paso, Tex. An incline shaft is reported to be 50 feet deep in lead-zinc ore. There is another shaft sunk vertically 45 feet deep, from which it is presumed the lead ore was produced.

*Wrightson district.*—Through the operations of three deep mines in 1911, 166 tons of ore, carrying 7,496 ounces of silver, 10,150 pounds of copper, and 2,058 pounds of lead, valued in all at $5,333, or an average of $32.13 per ton, were shipped to smelters from Patagonia. The principal producer was the Ivanhoe mine, which is opened by a vertical shaft 200 feet deep. The ore produced is oxidized with a siliceous gangue, carrying copper and important values in silver. Oxidation is reported to extend to the full depth of the shaft. Small shipments of copper ore were also made from the Mansfield property, which has a 30-ton copper-matting plant, which was not in operation in 1911. The Dixie mine produced a lead ore, carrying small values in copper and silver.

## YAVAPAI COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Yavapai County, Ariz., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 42,665.30 | $881,970 | 33,363.46 | $689,684 | − 9,301.84 | −$192,286 |
| Silver.....do.... | 669,702 | 377,839 | 764,744 | 405,314 | + 95,042 | + 27,475 |
| Copper.....pounds.. | 40,824,556 | 5,184,719 | 36,103,649 | 4,512,956 | −4,720,907 | − 671,763 |
| Lead.....do.. | 264,911 | 11,656 | 318,089 | 14,314 | + 53,178 | + 2,658 |
| Zinc.....do.... | ..... | ..... | 47,165 | 2,688 | + 47,165 | + 2,688 |
| Total..... | ..... | 6,456,184 | ..... | 5,624,956 | ..... | − 831,228 |

There was a large decrease in the tonnage of ore mined in Yavapai County from 417,308 tons in 1910 to 245,165 tons in 1911. The number of producers increased from 87 to 94, and the total average value per ton of the ore from $15.44 to $22.91, and the gold and silver value from $2.99 to $4.42 per ton. The smelting ore aggregated 196,311 tons, which contained 18,553.41 ounces of gold, 620,962 ounces of silver, 36,039,169 pounds of copper, 156,659 pounds of lead, and 38,252 pounds of zinc, valued in all at $5,226,769, or an average value of $26.62 per ton. The bulk of this ore was treated at the Jerome and Humboldt smelters and the remainder was shipped to Needles, Cal., and El Paso, Tex. A small lot of zinc sulphide ore

was diverted to an eastern refinery. Most of the concentrates produced were from ores first treated by the amalgamation process, and they produced 1,831 tons of oxide and sulphide concentrate, 42 tons of copper and iron sulphide concentrate, 327 tons of lead sulphide concentrate, and 39 tons of lead-zinc sulphide concentrate. These tonnages added to the ores directly concentrated aggregated 3,134 tons of concentrates containing 6,820.60 ounces of gold, 129,476 ounces of silver, 50,836 pounds of copper, 161,430 pounds of lead, and 8,913 pounds of zinc, valued in all at $223,743, or an average of $71.39 per ton. At gold and silver mills 39,652 tons of ore were treated, yielding 4,307.03 ounces of gold and 1,635 ounces of silver by the amalgamation process and 2,741.40 ounces of gold and 6,416 ounces of silver by cyanidation. The bullion from these two processes aggregated $149,971, or an average recovery value of $3.78 per ton. The placer yield reported by 15 producers aggregated $9,581 in gold and 44 ounces of silver. Of the different kinds of ore mined, there were 193,300 tons of copper ore, 51,084 tons of dry or siliceous ore, 719 tons of lead ore, and 62 tons of zinc ore.

*Agua Fria district.*—From 2 deep mines 157 tons of ore were produced, containing $1,381 in gold, 233 ounces of silver, and 37,187 pounds of copper, valued in all at $6,153, or an average of $39.19 per ton. The larger part of the ore was treated at an amalgamation mill, followed by concentration, and yielded bullion and concentrates. The remainder of the crude ore was shipped directly to smelters. The Pick & Drill property mined a large quantity of oxidized gold ore, from which a few tons of oxide and sulphide concentrates were saved, in addition to the gold bullion. The Hatch property produced sulphide copper ore with siliceous gangue, carrying gold and silver values. An incline shaft on the property is 250 feet deep.

*Big Bug district.*—Twenty-three deep mines and 8 placer properties yielded ore and bullion valued at $460,014, against an output made by 20 deep mines and placers from 6 different sources in 1910, when the total output was valued at $406,324. The tonnage of ore mined increased from $37,837 tons in 1910 to 42,338 tons in 1911. At milling plants using amalgamation and concentration processes 1,965 tons of ore were treated, yielding bullion containing $6,464 in gold, 198 ounces of silver, and 163 tons of concentrates, which contained $5,411 in gold, 2,000 ounces of silver, 1,823 pounds of copper, 46,994 pounds of lead, and 8,913 pounds of zinc. The concentrate was shipped to Blende, Colo. The output of smelting ore shipped increased from 29,545 tons in 1910 to 38,099 tons in 1911, the content of which was $55,633 in gold, 54,996 ounces of silver, 2,718,177 pounds of copper, and 20,112 pounds of lead. In addition to these shipments to smelters, there were 2,274 tons of old tailings smelted, containing gold, silver, and copper, which was valuable as converter lining. The largest producer of copper in the district was the Blue Bell mine, which is developed by an 850-foot incline shaft with about 5,000 feet of drifts and crosscuts. In 1911, 250 feet of shaft were sunk and 1,500 feet of drifting performed. The ore, which is an auriferous and argentiferous pyrite and chalcopyrite, in a gangue of silicified schist, was carried by an aerial tramway to the Blue Bell railroad siding and then shipped to the Humboldt smelter. The oxidized zone on the property extends from 50 to 150 feet in depth.

The mines operated continuously during 1911, until the smelter suspended operations the middle of November. The next largest producer of copper ore was the Lelan mines. The property is equipped with a 10-stamp amalgamation and concentration mill, which was not operated, as the ores mined were of such value as to permit their shipment to Humboldt. The mine is opened by a shaft 500 feet deep. Important shipments of concentrate were made from the Poland mine by lessees, who operated the mill on the property and produced bullion and concentrate and a small quantity of crude ore. The concentrates carried lead and important values in gold and silver, with a little copper. Other properties producing were the Ivanhoe, Veleda B., Silver Bell, Mountain Chief, Lookout, Independent No. 2 and Union, Swindler, Humboldt Consolidated, and Bordeaux. The last named produced a lead ore, which carried 0.68 ounce of gold, 26.4 ounces of silver, 52.4 per cent of lead, 6.4 per cent of iron, and 4 per cent of zinc. Lead concentrates were shipped to the El Paso smelter, and the zinc concentrates to Blende, Colo.

*Black Canyon district.*—Two properties producing 191 tons of ore were the Silver Cord and Parker groups. The latter property has a 5-stamp mill and a 25-ton cyanide plant, which was not operated in 1911 as the ore produced was of such a grade that it permitted shipment to the Humboldt smelter. The Silver Cord group produced a small quantity of lead ore containing important values in gold and silver with some copper.

*Black Hills district.*—The Arizona Central property yielded a shipping grade of copper ore carrying gold and silver.

*Black Rock district.*—Two deep mines yielded 339 tons of ore, containing gold, silver, and lead, having a total value of $4,886 and an average value of $14.41 per ton. The larger part of the ore yield was treated by hand jigs, producing lead concentrates, which were shipped to El Paso, Tex. The remainder of the ore was treated in an arrastre. The largest part of the production came from the Lavelle property and the bullion was produced from ore mined from the Cuckoo or Roby mine.

*Castle Creek district.*—The Dobler property was the only producer in the Castle Creek district and yielded gold bullion and oxidized copper ore of smelting grade, in which it is reported some bismuth occurs. The oxidized zone extends the full depth of the shaft, which is 265 feet down. The 5-stamp amalgamation mill on the property was operated only a short time.

*Cherry Creek district.*—Shipments of gold and silver bullion, concentrate, and crude ores to smelters were valued at $9,402 from 531 tons of ore in 1911, which averaged $17.71 per ton. In 1910 the total value of the output of 1,332 tons of ore was $6,452, or an average of $4.84 per ton. The concentrates shipped contained gold, silver, copper, and lead. The Etta, Federal, Hillside Consolidated, and Leghorn were the principal producers.

*Copper Basin district.*—The output of this district was 78 tons of ore from 2 properties in 1911. The Ruth property produced zinc-lead ore, which was shipped to Blende, Colo., and the lead ore from this mine was shipped to Needles, Cal. The property is developed by a vertical shaft 150 feet deep. A small shipment was made from a gold prospect in the district.

*Eureka district.*—Three mines, chiefly the Hillside and the Nieman & Cyglance properties, produced 610 tons of ore, containing $9,186 in gold, 4,348 ounces of silver, 1,044 pounds of copper, and 11,085 pounds of lead, valued in all at $12,120, or an average of $19.87 per ton. The bulk of this ore was treated at amalgamation and concentration mills, yielding gold and silver bullion and concentrate, which contained gold, silver, copper, and lead. The crude ore shipped to smelters carried the same metals. The principal operations were performed on the Hillside property, which is developed by a vertical shaft 100 feet deep. All the ore mined was oxidized and contained gold, silver, copper, lead, and zinc. The lead sulphide ore, with gold and silver and some copper, was shipped from the Cowboy property, taken from the Roughrider claim. The property is opened by a 60-foot tunnel. It is reported that sulphides occur at water level, which is at a depth of 50 feet.

*Granite district.*—Eighty-two tons of ore, containing gold, silver, and copper, were shipped to a copper plant from the Indiana claim, which is developed by a shaft 110 feet deep. The ore sold is oxidized, with a siliceous gangue.

*Hassayampa district.*—The metal yield of the district aggregated $20,027 in 1911 from 1,793 tons of ore and the bullion from the operations of 1 placer. Thirteen producers yielded ore which was valued at $10,276 in 1910. The bulk of the ore was treated at amalgamation mills, one of which was equipped for concentration and produced an iron concentrate containing gold and silver. The principal producer was the Black Pine mine, yielding oxidized and sulphide ores in almost equal quantities, containing small quantities of lead, zinc, and copper. The oxidized ores extend from 100 to 300 feet in depth. The property is opened by 5 adits, of which the greatest length is 700 feet. The ore, which came from development work only, was milled in a 5-foot Huntington mill equipped with amalgamation plates and 2 Wilfley concentrators. It is stated that the cyanide process would make a better yield, as only about 30 per cent of the values are saved. Important developments were made on the Climax group, which is equipped with a 10-stamp amalgamation mill, producing some bullion. The property is opened by 6,000 feet of tunnel work. The Venezia was another important producer of gold bullion and concentrates. The latter were stored for treatment later. This property is equipped with a 20-stamp mill of a daily capacity of 50 tons and the mine is opened by a shaft 100 feet deep with 300 feet of drifts. The ore is iron sulphide, in which the gold is not very free. The oxidized zone extends to a depth of about 100 feet. The property has been closed down for the purpose of putting in a cyanide mill, for which the grading and foundations have been completed.

*Martinez district.*—All of the ore mined in the district from 2 properties was concentrated, saving the auriferous iron sulphide and leaching the sands and slimes by cyanidation. The Congress mine was operated by lessees and the Alaska mine of the United Gold Mines Co. was operated most of the year. The 4-stamp Nissen mill on the property crushed 30 tons of ore per day. The yield of these properties aggregated $129.881 in value for the gold, silver, and copper.

*Peck district.*—There were 4 mines yielding ore in 1911, against 1 mine producing in 1910. The total output of 546 tons of ore was valued at $22,560, or an average of $41.32 per ton. The bulk of the output, or 470 tons, was treated at amalgamation mills, and some concentrate containing copper was saved. The remainder, 76 tons, carrying gold, silver, copper, and lead, was shipped to the smelter. The old workings of the Peck group were operated by a lessee who found small bodies of silver chloride ores. This property is opened by a shaft 500 feet deep and has 2,000 feet of drifts. It is equipped with a 10-stamp dry crushing amalgamation mill, which was not operated in 1911. The Lincoln mine was in the hands of lessees who operated the mine and mill for a short time, producing gold bullion and copper concentrates carrying gold and silver from sulphide ore with a siliceous gangue. The mine is opened by a vertical shaft 120 feet deep and has 2,200 feet of drifts. The 15-stamp amalgamation and concentration mill on the property was in operation a short time.

*Silver Mountain district.*—The Pacific Copper Mining Co. shipped copper iron sulphide ore containing gold and silver values. The property is opened by vertical shafts, the deepest of which is 475 feet, and has 3,465 feet of drifts and crosscuts. Over half of this development work was performed in 1911. It is reported that the oxidation zone extends only to a depth of 300 feet.

*Tiger and Pine Grove districts.*—Five mines in these districts produced an aggregate of 21,568 tons of ore, containing gold, silver, copper, and lead, having a total value of $173,562, and an average of $8.05 per ton. The bulk of the ore, 21,250 tons, was milled, the larger part, or 15,000 tons, producing gold bullion and some concentrate which contained gold, silver, and copper. The next largest quantity of ore, or 6,250 tons, was treated by concentration, yielding lead concentrate carrying considerable values in silver with some gold and copper. The crude ore shipped directly to smelters aggregated 318 tons, containing gold, silver, copper, and lead. The principal producer was the Tiger mine, which is opened by a shaft 585 feet deep and 3,320 feet of drifts. The ores produced are sulphide with a siliceous gangue. The oxidation zone is said to extend to a depth of 70 feet. The 20-stamp mill is equipped with amalgamation plates and Wilfley tables. The Springfield mine, which is opened by 3 shafts having a total depth of 140 feet and 1,100 feet of adits, was also a producer. The ore is considered copper sulphide with some gold and silver and a little lead, 60 per cent of silica and 12 per cent of iron. The Old Tiger mine, operated by the Yavapai Consolidated Co., yielded a sulphide ore carrying considerable values in gold and silver and small quantities of copper and lead. The mine is opened by a vertical shaft 750 feet deep and two incline shafts, 6,000 feet of drifts, and 1,500 feet of adits. The oxidized zone is said to extend to a depth of 30 feet in some places. The mine was operated during the entire year and the mill, which is equipped with 10 stamps, Wilfley tables, and vanners, was only operated the latter half of the year.

*Turkey Creek district.*—Eight deep mines and one placer reported the yield of 38 tons of selected ore and placer bullion, aggregating in value $3,001. The ore carried an average value of $76.11 per ton in

gold, silver, and lead. The principal production came from the R. and H. mine, which was under lease. It is opened by an adit 200 feet long and an incline winze 90 feet deep. The ore produced was a lead-zinc sulphide with siliceous gangue, carrying important silver values, largely ruby silver, which was shipped to a lead smelter. The oxidized zone is said to extend 40 feet below the adit. The Mastodon claim was also worked, producing a lead sulphide carrying small values in gold and silver. The property is opened by a shaft 60 feet deep and an adit 80 feet long. The Amazon claim, which is developed by a vertical shaft 150 feet deep, produced a selected quantity of auriferous iron sulphide ore.

*Verde district.*—The United Verde mine was the principal producer of copper ore, the metal content of which is converted to blister copper in the smelter located on the property. Some ores were shipped to the Humboldt and Swansea smelters. Ore from Arizona and California was also treated at the smelter on the property for use as converter lining. The entire output of the Cleopatra mine was treated at the Swansea smelter. The ores produced in this district are principally copper sulphides, carrying considerable values in gold and silver.

*Walker district.*—Twelve producers reported the production of 2,634 tons of ore, containing $31,643 in gold, 3,279 ounces of silver, 3,745 pounds of copper, and 23,589 pounds of lead, valued in all at $34,911, or an average of $13.25 per ton. The bulk of the ore, or 2,566 tons, was treated at gold and silver mills, yielding bullion and lead sulphide concentrate. The smelting ore, 68 tons in quantity, contained copper, lead, gold, and silver values. The largest tonnage mined was from the Mudhole and Sunflower mines and mill, operated by lessees. Part of the mill was operated until the latter part of 1911, producing a concentrate carrying gold, silver, and lead. The North Capitol, Pine Mountain, and Grubstake claims were also producers.

*Weaver district.*—The production of 3 deep mines aggregated 313 tons, and $4,813 was produced by 1 placer. The ore contained $7,423 in gold, 369 ounces of silver, 1,442 pounds of copper, and 5,148 pounds of lead, valued in all at $8,031, or an average of $25.66 per ton. Part of this ore was concentrated, yielding lead concentrate, and a small lot contained copper with gold and silver values, which was shipped directly to the smelters. The Rincon mine produced the largest amount of ore by lessees.

*White Picacho district.*—Two deep mines in this district produced small quantities of test ore, taken out in preparing the mines for a larger production. The Monarch mine, one of the shippers, is opened by two shafts 153 and 166 feet deep and several tunnels. The property has a new 100-ton concentration mill under construction and is to be equipped with a 100-ton semipyritic smelter. The ore will be treated in the concentration mill over rolls with dry classification, and the undersize crushed to 20 mesh in a Chilean mill and sized on jigs and tables. It is expected that the mill will be in full operation by June, 1912. The Gold Rope claim, which is opened by 2 shallow shafts, was also a small producer of gold and silver ore.

YUMA COUNTY.

In 1911 the quantity of ore mined in Yuma County by 40 producers aggregated 12,504 tons. This is 25,736 tons less than was mined by 28 operators in 1910. The decrease in tonnage caused a rise in value in the tonnage of ores from $11.39 in 1910 to $20.88 in 1911, and in the gold and silver value from $10.15 to $16.40. The larger part of the tonnage, or 6,993 tons, was treated at gold and silver mills, producing, by the amalgamation process, 2,795.98 ounces of gold and 1,217 ounces of silver, and by the cyanidation process 6,098.57 ounces of gold and 2,731 ounces of silver. All of this bullion was valued at $185,958, with an average recovery value of $26.59 per ton. The smelting ores, part of which were treated at Swansea, a little at Needles and El Paso, and the remainder at Humboldt, aggregated 5,161 tons, containing 724.81 ounces of gold, 4,538 ounces of silver, 416,868 pounds of copper, and 36,095 pounds of lead, valued in all at $71,121, or an average of $13.78 per ton. The yield of concentrates aggregated 49 tons. All except 14 tons of iron sulphide concentrate produced at gold and silver mills was the result of the concentration of 350 tons of ore. Concentrates shipped, containing gold, silver, and lead, had an average value of $81.41 per ton.

*Castle Dome district.*—The total production of the district aggregated $1,969 in gold, 1,597 ounces of silver, 39 pounds of copper, and 72,073 pounds of lead, valued in all at $6,064. This metal yield was produced from 5 deep mines and 3 placers.

The ore output aggregated 377 tons and had an average value of $12.32 per ton. The placers produced $1,414 in gold and 11 ounces of silver. The Chief of the Dome property was the largest producer of lead-sulphide ores carrying silver values. This ore was crushed by rolls and separated by hand jigs, producing a lead concentrate. The property is opened by an incline shaft 200 feet deep. Selected lead carbonates, mined from shallow workings, were shipped from the Sphinx of Arizona property.

*Cienega district.*—The output of 5 properties aggregated 29 tons, containing $656 in gold, 5 ounces of silver, 4,637 pounds of copper, valued in all at $1,239, or an average of $42.72 per ton.

*Ellsworth district.*—Ore and placer bullion produced from 11 deep mines and 2 placers was valued at $17,556 in 1911. The output in 1910 by 7 deep-mine operators aggregated $4,973, and the average value per ton of 143 tons in that year was $34.77. In 1911, 1,006 tons of ore were produced, averaging $17.02 per ton for the gold, silver, copper, and lead content. The largest output of ore was made from the Soccorro mine, which is opened by an incline shaft 700 feet deep. The only work done in 1911 was the milling of ore in the 20-stamp amalgamation and concentration mill on the property. The ore treated was partly oxidized and partly sulphide with a siliceous gangue. It is reported that the oxidized zone extends to a depth of about 250 feet. Active work was also carried on at the Arizona Success, Desert, and a number of prospects. The Desert mine is equipped with a 10-stamp mill, 1 Wilfley table, and 1 slime table. The Cunningham mine was under lease and produced some sulphide copper ore. The property is developed by a vertical shaft 400 feet deep and has about 1,000 feet

of drifts. The oxidized zone is said to extend to a depth of about 300 feet.

*Kofa district.*—The principal producer in the district was the North Star mine, which is opened by a vertical shaft 800 feet deep and has 10,000 feet of drifts. The shaft was sunk 200 feet deeper and 1,500 feet of drifts were completed during 1911. The ore was oxidized with a siliceous gangue and was treated in the 100-ton amalgamation and cyanide plant, which is equipped with crushers, rolls, tube mills, with agitation and aeration of the slimes and cyanides. The property was closed in August and the statement was circulated that the mine was worked out.

*Planet district.*—Some ore was treated at the Clara smelter at Swansea. Part of this production was that of the Clara property. An important tonnage of ores was shipped from other properties. The smelter ran only a short time, and one lot of blister copper was forwarded to an eastern refinery and the ore piles were cleaned up and reshipped for treatment to other smelting plants.

*Plomosa district.*—The deep-mine production was made by 13 producers, who mined 278 tons of ore, containing $8,622 in gold, 1,456 ounces of silver, 12,211 pounds of copper, and 12,453 pounds of lead, valued in all at $11,481, or an average of $41.30 per ton. Six placer producers shipped bullion from dry-placer operations valued at $2,491 in gold and containing 14 ounces of silver. The production in 1910, made by 10 operators of deep mines, was valued at $14,572, or an average of $24.78 per ton. The placer production was valued at $2,368 in gold and contained 28 ounces of silver. Most of the ore mined in 1911 was produced from the Stafford property, which is developed by a vertical shaft 50 feet deep. The ore was treated in a 20-ton slow-speed Lane mill. The Blue Slate property also yielded an oxidized copper ore, which was mined by lessees. The Arizona Pride produced oxidized copper ore, which was mined by lessees from the vertical shaft 55 feet deep. The Goodman property yielded gold and silver bullion from ore which was treated in a 1-stamp Nissen mill by the amalgamation process. The property is opened to a depth of 125 feet.

## CALIFORNIA.

By Charles G. Yale.

### PRODUCTION.

For the calendar year 1911 the California production of gold, silver, copper, lead, and zinc was valued at $25,174,677, a decrease of $1,845,728, as compared with $27,020,405 in 1910. This decrease was mainly due to the lessened output of copper, owing to the enforced curtailment of operations at the smelters by reason of litigation over the smelter-fume conditions. This also affected the silver output materially, as most of the silver of California is obtained in the smelting of copper ores. The increase in gold production in 1911 was 1,135.26 fine ounces, valued at $23,468; the decrease in silver was 569,640 fine ounces in quantity and $320,310 in value; the decrease in copper was 12,384,620 pounds in quantity and $1,645,479 in value; and the decrease in lead was 1,472,866 pounds in quantity and $63,408 in value. There was no yield of zinc in California in 1910,

but in 1911 there was a production of 2,807,035 pounds in quantity, valued at $160,001.

In 1911, 1,181 properties were reported productive, of which 596 were deep mines and 585 were placers of various kinds. There were 102 more producing mines in 1911 than in 1910. The deep mines may be classified by metal produced as follows: Gold, 522; silver, 11; silver-lead, 31; copper, 30; zinc, 2. The increase in the total number of 81 deep mines was made up of 37 gold, 19 copper, 2 silver, 21 silver-lead, and 2 zinc. Of the placer mines 169 are hydraulic, 65 dredges, 141 drift, and 210 surface placers. The dredges are enumerated by the number of boats at work, and were operated by 34 companies, as compared with 41 companies in 1910. There was only 1 more hydraulic mine producing in 1911 than in 1910, but 2 more drift and 25 more surface placers; the number of operating dredges was less by 7. There were 81 more deep mines producing in 1911 than in 1910, and 21 more placers.

The 596 deep mines producing in the State in 1911 made an output of 2,797,261 tons of ore, 299,376 tons more than in 1910. Of this output 2,296,347 tons were siliceous ore, 494,281 tons copper ore, 2,008 tons lead ore, and 4,625 tons zinc ore. The siliceous ore output increased by 330,051 tons in 1911, the copper ore decreased by 222,404 tons, the lead ore decreased by 15,896 tons, and the zinc ore increased by 4,625 tons.

The siliceous ore yielded an average per ton of $4.57 in gold and silver, the copper ore $1.79, and the lead ore $23.08. The average in gold and silver from all the ores treated in the State in 1911 was $4.08.

The 2,797,261 tons of ore of all classes treated in the State in 1911 yielded 520,146.43 fine ounces of gold, valued at $10,752,381; 1,230,904 ounces of silver, valued at $652,379; 36,316,136 pounds of copper, valued at $4,539,517; 1,398,111 pounds of lead, valued at $62,915; 2,807,035 pounds of zinc, valued at $160,001.

The value of the metals obtained from ore mined and treated in California in 1911 was $16,167,193, an average value per ton of $5.49. In 1910 the output was 2,697,885 tons, valued at $18,109,008, an average value per ton of $6.71; in 1909 the output was 3,041,688 tons, valued at $19,715,314, an average of $6.48 per ton; and in 1908 the output was 2,546,908 tons, valued at $16,536,226, an average value per ton of $6.49.

In 1911 there were treated at gold and silver mills 2,156,950 tons of ore, containing altogether $9,921,306 in gold, an average value of $4.60 per ton, and 177,203 ounces of silver, valued at $93,918, an average value of 4 cents per ton. This gives a total value of $10,015,224 in gold and silver thus treated, and an average value per ton of $4.64 in both metals. The average value in 1910 was $5.25 per ton; in 1909 it was $4.88; and in 1908 it was $5.08.

There was recovered as bullion in the mills $7,868,365 in gold, averaging $3.65 per ton, and 141,747 ounces of silver, valued at $75,126, averaging about 3 cents per ton, a total of $7,943,491 in gold and silver, averaging $3.68 in both metals.

From 2,156,950 tons of gold milling ore 40,157 tons of concentrates were obtained, valued at $2,052,941 in gold, an average of $51.12 per ton, and 35,466 ounces of silver, valued at $18,792, an average of 46

cents per ton. This was a yield in gold and silver of $2,071,733, or an average value recovered from the concentrates of $51.58 per ton in gold and silver.

Of smelting ores (mainly copper ores) there were 538,214 tons, valued at $641,495 in gold, an average of $1.19 per ton, and 1,004,472 fine ounces of silver, valued at $532,370, an average recovery of $1 per ton. The total yield of gold and silver in the smelting ores was $1,173,865, or an average value of $2.19 per ton.

There was also 103,097 tons of old tailings treated, producing $189,580 in gold, an average of $1.86, and 49,219 ounces of silver, valued at $26,086, an average of 25 cents per ton. The total gold and silver in the tailings was valued at $215,666, an average of $2.11 per ton.

The 585 productive placer mines in California in 1911 yielded 434,723.24 fine ounces of gold, valued at $8,986,527, and 39,541 ounces of silver, valued at $20,957, a total value in gold and silver of $9,007,484. This was an increase of $96,087 over the placer output in gold and silver of 1910. The gold increase was $97,732, but the silver decreased by 2,315 ounces. In gold production the dredge properties of California showed an increase of $116,207 in 1911 over 1910, and the hydraulic mines an increase of $39,988. In the same period the drift mines showed a decreased output of $37,029, and the surface placers a decrease of $21,434.

The statement of production in California in 1910 and 1911, showing increase or decrease and value at each year's commercial prices, is as follows:

*Mine production of gold, silver, copper, lead, and zinc in California in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+), decrease(−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 953,734.41 | $19,715,440 | 954,869.67 | $19,738,908 | + 1,135.26 | + $23,468 |
| Silver.....do.... | 1,840,085 | 993,646 | 1,270,445 | 673,336 | − 569,640 | − 320,310 |
| Copper.....pounds.. | 48,700,756 | 6,184,996 | 36,316,136 | 4,539,517 | −12,384,620 | −1,645,479 |
| Lead.....do.... | 2,870,977 | 126,323 | 1,398,111 | 62,915 | − 1,472,866 | − 63,408 |
| Zinc.....do.... | ..... | ..... | 2,807,035 | 160,001 | + 2,807,035 | + 160,001 |
| Total..... | ..... | 27,020,405 | ..... | 25,174,677 | ..... | −1,845,728 |

The table following shows the production of gold, silver, copper, lead, and zinc in California in 1911, by counties.

*Production of precious metals, by source and counties, and production of copper, lead, and zinc, by counties, in California in 1911.*

| County. | Ore treated. | Deep-mine gold. | | Placer gold. | | Total gold. | |
|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | *Tons.* | *Fine ozs.* | | *Fine ozs.* | | *Fine ozs.* | |
| Amador | 656,806 | 135,801.40 | $2,807,264 | 1,215.71 | $25,131 | 137,017.11 | $2,832,395 |
| Butte | 2,575 | 569.56 | 11,774 | 111,824.72 | 2,311,622 | 112,394.28 | 2,323,396 |
| Calaveras | 482,983 | 41,972.62 | 867,651 | 11,835.62 | 244,664 | 53,808.24 | 1,112,315 |
| Colusa and Lassen | 522 | 137.24 | 2,837 | ..... | ..... | 137.24 | 2,837 |
| Del Norte | ..... | ..... | ..... | 84.32 | 1,743 | 84.32 | 1,743 |
| Eldorado | 11,444 | 3,068.72 | 63,436 | 3,411.94 | 70,531 | 6,480.66 | 133,967 |
| Fresno | 1,515 | 809.27 | 16,729 | 34.44 | 712 | 843.71 | 17,441 |
| Humboldt | 70 | 43.78 | 905 | 1,647.70 | 34,061 | 1,691.48 | 34,966 |
| Imperial and San Diego | 23,181 | 4,733.73 | 97,855 | ..... | ..... | 4,733.73 | 97,855 |
| Inyo | 101,662 | 27,812.96 | 574,945 | ..... | ..... | 27,812.96 | 574,945 |
| Kern | 180,687 | 26,797.04 | 553,944 | 170.62 | 3,527 | 26,967.66 | 557,471 |
| Madera | 310 | 94.72 | 1,958 | ..... | ..... | 94.72 | 1,958 |
| Mariposa | 18,196 | 8,225.49 | 170,036 | 120.74 | 2,496 | 8,346.23 | 172,532 |
| Merced, Shasta, Stanislaus, and Trinity | ..... | ..... | ..... | 14,877.14 | 307,538 | 14,877.14 | 307,538 |
| Modoc | 1,186 | 961.45 | 19,875 | ..... | ..... | 961.45 | 19,875 |
| Mono | 33,469 | 12,637.10 | 261,232 | ..... | ..... | 12,637.10 | 261,232 |
| Nevada | 263,062 | 104,184.61 | 2,153,687 | 2,199.13 | 45,460 | 106,383.74 | 2,199,147 |
| Placer | 6,181 | 1,850.73 | 38,258 | 10,305.81 | 213,040 | 12,156.54 | 251,298 |
| Plumas | 47,470 | 7,706.18 | 159,301 | 3,361.29 | 69,484 | 11,067.47 | 228,785 |
| Riverside and Los Angeles | 4,875 | 997.64 | 20,623 | ..... | ..... | 997.64 | 20,623 |
| Sacramento | ..... | ..... | ..... | 87,695.46 | 1,812,826 | 87,695.46 | 1,812,826 |
| San Bernardino | 18,190 | 6,122.39 | 126,561 | 38.99 | 806 | 6,161.38 | 127,367 |
| Shasta | 520,795 | 50,714.56 | 1,048,363 | 557.18 | 11,518 | 51,271.74 | 1,059,881 |
| Sierra | 35,360 | 12,467.93 | 257,735 | 9,857.76 | 203,778 | 22,325.69 | 461,513 |
| Siskiyou | 9,747 | 5,054.66 | 104,489 | 15,373.96 | 317,808 | 20,428.62 | 422,297 |
| Trinity | 67,925 | 14,410.91 | 297,900 | 15,201.80 | 314,249 | 29,612.71 | 612,149 |
| Tuolumne | 308,652 | 52,576.37 | 1,086,850 | 320.92 | 6,634 | 52,897.29 | 1,093,484 |
| Yuba | 398 | 395.37 | 8,173 | 144,587.99 | 2,988,899 | 144,983.36 | 2,997,072 |
| Total | 2,797,261 | 520,146.43 | 10,752,381 | 434,723.24 | 8,986,527 | 954,869.67 | 19,738,908 |

| County. | Deep-mine silver. | | Placer silver. | | Total silver. | | Copper. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | *Fine ozs.* | | *Fine ozs.* | | *Fine ozs.* | | *Pounds.* | |
| Amador | 54,349 | $28,805 | 177 | $94 | 54,526 | $28,899 | 227,848 | $28,481 |
| Butte | 604 | 320 | 9,023 | 4,782 | 9,627 | 5,102 | ..... | ..... |
| Calaveras | 124,770 | 66,128 | 1,706 | 904 | 126,476 | 67,032 | 5,681,200 | 710,150 |
| Colusa and Lassen | 530 | 281 | ..... | ..... | 530 | 281 | ..... | ..... |
| Del Norte | ..... | ..... | 13 | 7 | 13 | 7 | ..... | ..... |
| Eldorado | 1,111 | 589 | 794 | 421 | 1,905 | 1,010 | ..... | ..... |
| Fresno | 145 | 77 | 8 | 4 | 153 | 81 | ..... | ..... |
| Humboldt | 27 | 14 | 292 | 155 | 319 | 169 | ..... | ..... |
| Imperial and San Diego | 357 | 189 | ..... | ..... | 357 | 189 | ..... | ..... |
| Inyo | 86,185 | 45,678 | ..... | ..... | 86,185 | 45,678 | 29,504 | 3,688 |
| Kern | 10,962 | 5,810 | 43 | 23 | 11,005 | 5,833 | 33,224 | 4,153 |
| Madera | 145 | 77 | ..... | ..... | 145 | 77 | 24,488 | 3,061 |
| Mariposa | 2,602 | 1,379 | 21 | 11 | 2,623 | 1,390 | 13,528 | 1,691 |
| Merced, Shasta, Stanislaus, and Trinity | ..... | ..... | 2,134 | 1,131 | 2,134 | 1,131 | ..... | ..... |
| Modoc | 685 | 363 | ..... | ..... | 685 | 363 | ..... | ..... |
| Mono | 66,996 | 35,508 | ..... | ..... | 66,996 | 35,508 | ..... | ..... |
| Nevada | 29,187 | 15,469 | 419 | 222 | 29,606 | 15,691 | ..... | ..... |
| Placer | 2,777 | 1,472 | 2,100 | 1,113 | 4,877 | 2,585 | ..... | ..... |
| Plumas | 1,672 | 886 | 451 | 239 | 2,123 | 1,125 | 1,328 | 166 |
| Riverside and Los Angeles | 4,002 | 2,121 | ..... | ..... | 4,002 | 2,121 | 7,000 | 875 |
| Sacramento | ..... | ..... | 5,749 | 3,047 | 5,749 | 3,047 | ..... | ..... |
| San Bernardino | 67,057 | 35,540 | 4 | 2 | 67,061 | 35,542 | 679,984 | 84,998 |
| Shasta | 730,030 | 386,916 | 141 | 75 | 730,171 | 386,991 | 29,618,032 | 3,702,254 |
| Sierra | 9,100 | 4,823 | 1,474 | 781 | 10,574 | 5,604 | ..... | ..... |
| Siskiyou | 2,130 | 1,129 | 2,702 | 1,432 | 4,832 | 2,561 | ..... | ..... |
| Trinity | 10,262 | 5,439 | 2,524 | 1,338 | 12,786 | 6,777 | ..... | ..... |
| Tuolumne | 24,930 | 13,213 | 57 | 30 | 24,987 | 13,243 | ..... | ..... |
| Yuba | 289 | 153 | 9,709 | 5,146 | 9,998 | 5,299 | ..... | ..... |
| Total | 1,230,904 | 652,379 | 39,541 | 20,957 | 1,270,445 | 673,336 | 36,316,136 | 4,539,517 |

*Production of precious metals, by source and counties, and production of copper, lead, and zinc, by counties, in California in 1911*—Continued.

| County. | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | |
| Amador | | | | | $2,889,775 |
| Butte | | | | | 2,328,498 |
| Calaveras | | | | | 1,889,497 |
| Colusa and Lassen | | | | | 3,118 |
| Del Norte | | | | | 1,750 |
| Eldorado | | | | | 134,977 |
| Fresno | | | | | 17,522 |
| Humboldt | | | | | 35,135 |
| Imperial and San Diego | | | | | 98,044 |
| Inyo | 1,329,756 | $59,839 | 2,624,719 | $149,609 | 833,759 |
| Kern | 600 | 27 | | | 567,484 |
| Madera | | | | | 5,096 |
| Mariposa | | | | | 175,613 |
| Merced, Shasta, Stanislaus, and Trinity | | | | | 308,669 |
| Modoc | | | | | 20,238 |
| Mono | 44,289 | 1,993 | | | 298,733 |
| Nevada | | | | | 2,214,838 |
| Placer | | | | | 253,883 |
| Plumas | | | | | 230,076 |
| Riverside and Los Angeles | | | | | 23,619 |
| Sacramento | | | | | 1,815,873 |
| San Bernardino | 23,466 | 1,056 | 182,316 | 10,392 | 259,355 |
| Shasta | | | | | 5,149,126 |
| Sierra | | | | | 467,117 |
| Siskiyou | | | | | 424,858 |
| Trinity | | | | | 618,926 |
| Tuolumne | | | | | 1,106,727 |
| Yuba | | | | | 3,002,371 |
| Total | 1,398,111 | 62,915 | 2,807,035 | 160,001 | 25,174,677 |

## GOLD.

The total gold production in California in 1911 was 954,869.67 fine ounces, valued at $19,738,908, as compared with 953,734.41 fine ounces, valued at $19,715,440 in 1910. The increase for 1911 was therefore 1,135.26 fine ounces, valued at $23,468. The deep mines of the State yielded 520,146.43 fine ounces, valued at $10,752,381. Of this deep-mine gold, 499,123.29 fine ounces, valued at $10,317,794, was derived from siliceous ore; 20,694.28 fine ounces, valued at $427,789, was from copper ore; and 328.86 fine ounces, valued at $6,798, was from lead ore.

The total placer yield of gold in 1911 was 434,723.24 fine ounces, valued at $8,986,527. Of this, $675,486 was derived from 169 hydraulic mines, $7,666,461 from 65 dredges, $479,900 from 141 drift mines, and $164,680 from 210 surface placer or sluicing mines. It will be seen that the dredges produced $6,346,395 more gold in 1911 than all the hydraulic, drift, and surface placers combined. The deep mines of California produced $1,765,854 more gold than the combined placers in 1911. The placers produced 45.53 per cent of the entire yield in 1911, and the deep mines 54.47 per cent, which ratio is about the same as that of 1910.

The dredges in the State produced 38.84 per cent of the total gold yield from all sources in 1911. Of total placer gold, the dredges produced 85.32 per cent, the hydraulic mines 7.51 per cent, the drift mines 5.34 per cent, and the surface or sluicing mines 1.83 per cent. The dredge mining record in gold in the last 12 years is shown as follows, with the increase or decrease for each year:

*Value of gold won by dredging in California, 1899–1911, with increase (+) or decrease (−), by years.*

| Year. | Value. | Increase(+) or decrease (−). |
|---|---|---|
| 1899 | $206,302 | |
| 1900 | 200,929 | − $5,373 |
| 1901 | 471,762 | + 270,833 |
| 1902 | 867,665 | + 395,903 |
| 1903 | 1,475,749 | + 608,084 |
| 1904 | 2,187,038 | + 711,289 |
| 1905 | 3,276,141 | +1,089,103 |
| 1906 | 5,098,359 | +1,822,218 |
| 1907 | 5,065,437 | − 32,922 |
| 1908 | 6,536,189 | +1,470,752 |
| 1909 | 7,382,950 | + 846,761 |
| 1910 | 7,550,254 | + 167,304 |
| 1911 | 7,666,461 | + 116,207 |
| Total | 47,985,236 | |

The three great dredging fields of the State are at Oroville, Butte County; Folsom, Sacramento County; and near Marysville, Yuba County. Dredges are also operated in seven other counties, but mainly in isolated localities with only one or two machines at work in each. In these districts outside the main fields named the machines are not usually of such large capacity as those in the fields where there are numerous dredges. The Yuba County field decreased its annual output of gold in 1911 by $207,739, Butte County decreased by $137,471, and Sacramento County increased by $435,477. In Yuba County there were 13 dredges operating in 1911 as compared with 15 in 1910; in Butte County there were 30 dredges as compared with 32 in 1910; and in Sacramento County there were 10 dredges as compared with 8 in 1910. In the whole State there were 65 dredges operating in 1911, as compared with 72 in 1910. The details of these changes will be described under the headings of the respective counties where dredging was being carried on in 1911.

Of the 32 counties producing gold in California, 10 yielded no placer gold, and 4 yielded no gold from deep mines. Eight counties yielded over $1,000,000 each in gold in 1911, as follows: Yuba, $2,997,072; Amador, $2,832,395; Butte, $2,323,396; Nevada, $2,199,147; Sacramento, $1,812,826; Calaveras, $1,112,315; Tuolumne, $1,093,484; and Shasta, $1,059,881.

The largest production of gold in California in 1911 came from Yuba County, as in 1910. The most productive county in gold from deep mines is Amador, which led Nevada County in this respect in 1911 by $653,577. The leading hydraulic mining county was Trinity; the greatest gold producer from drift mines was Placer, although Sierra ran a very close second; the largest producer in gold from dredge mines was Yuba County, and the largest from surface or sluicing mines was Plumas. This is precisely the same rank as prevailed in the calendar year 1910. The county which showed the largest increase of gold yield in 1911, as compared with 1910, was Tuolumne, with an increase of $477,858, followed by Sacramento with $415,952, Amador with $186,149, Inyo with $166,436, Sierra with $149,478, and Trinity with $142,306. Some counties showed material decrease in gold output for the year, notably Shasta, $413,134, Nevada, $334,336, Yuba, $207,201, Mono, $174,492, Butte, $164,395,

and Mariposa, $145,048. The combined decrease of these counties showing a lessened output was $1,684,250, and the combined increase in the other counties was $1,707,718, a total net increase of gold yield in California of $23,468.

The production of gold from placers and from different kinds of ore in California in 1911 by counties, in fine ounces, is given in the following table:

*Source of gold production in California by kinds of ore in 1911, by counties, in fine ounces.*

| County. | Placers. | Deep mines. | | | | Grand total. |
|---|---|---|---|---|---|---|
| | | Siliceous ore. | Copper ores. | Lead ores. | Total. | |
| Amador | 1,215.71 | 135,108.48 | 692.92 | ..... | 135,801.40 | 137,017.11 |
| Butte | 111,824.72 | 569.56 | ..... | ..... | 569.56 | 112,394.28 |
| Calaveras | 11,835.62 | 38,597.49 | 3,375.13 | ..... | 41,972.62 | 53,808.24 |
| Colusa and Lassen | ..... | 137.24 | ..... | ..... | 137.24 | 137.24 |
| Del Norte | 84.32 | ..... | ..... | ..... | ..... | 84.32 |
| Eldorado | 3,411.94 | 3,068.72 | ..... | ..... | 3,068.72 | 6,480.66 |
| Fresno | 34.44 | 809.27 | ..... | ..... | 809.27 | 843.71 |
| Humboldt | 1,647.70 | 43.78 | ..... | ..... | 43.78 | 1,691.48 |
| Imperial and San Diego | ..... | 4,733.73 | ..... | ..... | 4,733.73 | 4,733.73 |
| Inyo | ..... | 27,557.11 | 16.78 | 239.07 | 27,812.96 | 27,812.96 |
| Kern | 170.62 | 26,762.02 | 35.02 | ..... | 26,797.04 | 26,967.66 |
| Madera | ..... | 94.72 | ..... | ..... | 94.72 | 94.72 |
| Mariposa | 120.74 | 8,204.50 | 20.99 | ..... | 8,225.49 | 8,346.23 |
| Merced, Shasta, Stanislaus and Trinity | 14,877.14 | ..... | ..... | ..... | ..... | 14,877.14 |
| Modoc | ..... | 961.45 | ..... | ..... | 961.45 | 961.45 |
| Mono | ..... | 12,624.23 | ..... | 12.87 | 12,637.10 | 12,637.10 |
| Nevada | 2,199.13 | 104,184.61 | ..... | ..... | 104,184.61 | 106,383.74 |
| Placer | 10,305.81 | 1,850.73 | ..... | ..... | 1,850.73 | 12,156.54 |
| Plumas | 3,361.29 | 7,706.18 | ..... | ..... | 7,706.18 | 11,067.47 |
| Riverside and Los Angeles | ..... | 930.30 | 67.34 | ..... | 997.64 | 997.64 |
| Sacramento | 87,695.46 | ..... | ..... | ..... | ..... | 87,695.46 |
| San Bernardino | 38.99 | 2,080.95 | 3,964.52 | 76.92 | 6,122.39 | 6,161.38 |
| Shasta | 557.18 | 38,192.98 | 12,521.58 | ..... | 50,714.56 | 51,271.74 |
| Sierra | 9,857.76 | 12,467.93 | ..... | ..... | 12,467.93 | 22,325.69 |
| Siskiyou | 15,373.96 | 5,054.66 | ..... | ..... | 5,054.66 | 20,428.62 |
| Trinity | 15,201.80 | 14,410.91 | ..... | ..... | 14,410.91 | 29,612.71 |
| Tuolumne | 320.92 | 52,576.37 | ..... | ..... | 52,576.37 | 52,897.29 |
| Yuba | 144,587.99 | 395.37 | ..... | ..... | 395.37 | 144,983.36 |
| Total | 434,723.24 | 499,123.29 | 20,694.28 | 328.86 | 520,146.43 | 954,869.67 |

Comparisons of these totals with the gold output of 1910 are as follows:

*Mine production of gold in California in 1910 and 1911, with classification of source, in fine ounces.*

| Year. | Placers. | Deep mines. | | | | Grand total. | |
|---|---|---|---|---|---|---|---|
| | | Siliceous ore. | Copper ores. | Lead ores. | Total. | Quantity. | Value. |
| 1910 | 429,995.46 | 490,705.36 | 31,844.68 | 1,188.91 | 523,738.95 | 953,734.41 | $19,715,440 |
| 1911 | 434,723.24 | 499,123.29 | 20,694.28 | 328.86 | 520,146.43 | 954,869.67 | 19,738,908 |
| Increase (+) or decrease (−) | +4,727.78 | +8,417.93 | −11,150.40 | −860.05 | −3,592.52 | +1,135.26 | +23,468 |

From the siliceous ore and from old tailings treated in 1911 the recovery of gold by processes in California was as follows: By amalgamation, 353,443 fine ounces; by cyanidation, 42,108 ounces; and by chlorination, 20,006 ounces.

The source of placer gold, by counties and from various kinds of mines, is shown as follows:

*Source of placer gold in California in 1911, by counties.*

| County. | Hydraulic. | Dredging. | Drift. | Surface placers. | Total. |
|---|---|---|---|---|---|
| Amador | $12,606 | ..... | $9,302 | $3,223 | $25,131 |
| Butte | 9,152 | $2,251,764 | 22,937 | 27,769 | 2,311,622 |
| Calaveras | 19,509 | 203,043 | 8,781 | 13,331 | 244,664 |
| Del Norte | 854 | ..... | ..... | 889 | 1,743 |
| Eldorado | 1,100 | ..... | 63,740 | 5,691 | 70,531 |
| Fresno | ..... | ..... | 491 | 221 | 712 |
| Humboldt | 33,834 | ..... | ..... | 227 | 34,061 |
| Kern | 1,315 | ..... | 2,005 | 207 | 3,527 |
| Mariposa | ..... | ..... | ..... | 2,496 | 2,496 |
| Merced, Shasta, Stanislaus, and Trinity [a] | ..... | 307,538 | ..... | ..... | 307,538 |
| Nevada | 8,000 | ..... | 24,352 | 13,108 | 45,460 |
| Placer | 8,000 | 49,639 | 146,775 | 8,626 | 213,040 |
| Plumas | 4,845 | ..... | 33,500 | 31,139 | 69,484 |
| Sacramento | ..... | 1,805,071 | 7,755 | ..... | 1,812,826 |
| San Bernardino | ..... | ..... | ..... | 806 | 806 |
| Shasta | ..... | ..... | 1,819 | 9,699 | 11,518 |
| Sierra | 50,016 | ..... | 146,712 | 7,050 | 203,778 |
| Siskiyou | 217,579 | 84,669 | 6,545 | 9,015 | 317,808 |
| Trinity | 308,676 | ..... | ..... | 5,573 | 314,249 |
| Tuolumne | ..... | ..... | 5,186 | 1,448 | 6,634 |
| Yuba | ..... | 2,964,737 | ..... | 24,162 | 2,988,899 |
| Total | 675,486 | 7,666,461 | 479,900 | 164,680 | 8,986,527 |

[a] Yield of single dredge in each county combined to conceal separate output.

The increase or decrease of gold production, by counties, in 1911 as compared with 1910, is shown in the following table:

*Increase and decrease in gold production in California in 1911, by counties.*

| County. | Increase. | Decrease. |
|---|---|---|
| Amador | $186,149 | ..... |
| Butte | ..... | $164,395 |
| Calaveras | ..... | 35,390 |
| Colusa and Lassen | ..... | 79,343 |
| Del Norte | ..... | 645 |
| Eldorado | ..... | 37,337 |
| Fresno | 14,068 | ..... |
| Humboldt | ..... | 323 |
| Imperial and San Diego | 10,514 | ..... |
| Inyo | 166,436 | ..... |
| Kern | ..... | 62,503 |
| Madera | ..... | 8,118 |
| Mariposa | ..... | 145,048 |
| Merced, Shasta, Stanislaus, and Trinity | 1,630 | ..... |
| Modoc | 14,437 | ..... |
| Mono | ..... | 174,492 |
| Monterey, San Luis Obispo, and Santa Cruz | ..... | 1,013 |
| Nevada | ..... | 334,336 |
| Placer | ..... | 5,893 |
| Plumas | 41,578 | ..... |
| Riverside and Los Angeles | 15,038 | ..... |
| Sacramento | 415,952 | ..... |
| San Bernardino | 72,274 | ..... |
| Shasta | ..... | 413,134 |
| Sierra | 149,478 | ..... |
| Siskiyou | ..... | 15,079 |
| Trinity | 142,306 | ..... |
| Tuolumne | 477,858 | ..... |
| Yuba | ..... | 207,201 |
| Total | 1,707,718 | 1,684,250 |
| Total increase | 23,468 | ..... |

## SILVER.

The yield of silver in California in 1911 was 1,270,445 fine ounces, valued at $673,336, a decrease in quantity of 569,640 ounces, and in value of $320,310. The larger part of the output, 864,397 fine ounces, valued at $458,130, was derived from the smelting of copper ores. The siliceous ore, both milled and smelted, yielded 291,896 fine ounces, valued at $154,705. The largest single production from siliceous ore, 52,651 ounces, valued at $27,905, came from Mono County. The largest production of silver was, as has been the case for some years, from Shasta County, which yielded from copper ores, 706,445 ounces, valued at $374,416, which, with 23,585 ounces from siliceous ore, and 141 ounces from placers, made a total silver yield from the county in 1911 of 730,171 ounces, valued at $386,991. The falling off in output of copper in this county in 1911 as compared with 1910 was 10,779,252 pounds, which is a sufficient explanation of why the county only produced 706,445 ounces of silver from its copper ores in 1911, whereas the yield from the same source in 1910 was 1,192,520 ounces. The silver obtained with the gold in placer mining in the State in 1911 was 39,541 ounces, valued at $20,957, as compared with 41,856 ounces in 1910. The largest producer of silver from placers was Yuba County with 9,709 ounces, valued at $5,146.

The following table shows the source of silver output in California in 1911, by placers and kinds of ore, in fine ounces:

*Source of silver production in California by kinds of ore in 1911, by counties, in fine ounces.*

| County. | Placers. | Deep mines. | | | | Grand total. |
|---|---|---|---|---|---|---|
| | | Siliceous ore. | Copper ores. | Lead ores. | Total. | |
| Amador | 177 | 34,398 | 19,951 | | 54,349 | 54,526 |
| Butte | 9,023 | 604 | | | 604 | 9,627 |
| Calaveras | 1,706 | 16,783 | 107,987 | | 124,770 | 126,476 |
| Colusa and Lassen | | 530 | | | 530 | 530 |
| Del Norte | 13 | | | | | 13 |
| Eldorado | 794 | 1,111 | | | 1,111 | 1,905 |
| Fresno | 8 | 145 | | | 145 | 153 |
| Humboldt | 292 | 27 | | | 27 | 319 |
| Imperial and San Diego | | 357 | | | 357 | 357 |
| Inyo | | 28,545 | 1,551 | 56,089 | 86,185 | 86,185 |
| Kern | 43 | 10,011 | 951 | | 10,962 | 11,005 |
| Madera | | 90 | 55 | | 145 | 145 |
| Mariposa | 21 | 2,423 | 179 | | 2,602 | 2,623 |
| Merced, Shasta, Stanislaus, and Trinity | 2,134 | | | | | 2,134 |
| Modoc | | 685 | | | 685 | 685 |
| Mono | | 52,651 | | 14,345 | 66,996 | 66,996 |
| Nevada | 419 | 29,187 | | | 29,187 | 29,606 |
| Placer | 2,100 | 2,777 | | | 2,777 | 4,877 |
| Plumas | 451 | 1,672 | | | 1,672 | 2,123 |
| Riverside and Los Angeles | | 3,974 | 28 | | 4,002 | 4,002 |
| Sacramento | 5,749 | | | | | 5,749 |
| San Bernardino | 4 | 35,630 | 27,250 | 4,177 | 67,057 | 67,061 |
| Shasta | 141 | 23,585 | 706,445 | | 730,030 | 730,171 |
| Sierra | 1,474 | 9,100 | | | 9,100 | 10,574 |
| Siskiyou | 2,702 | 2,130 | | | 2,130 | 4,832 |
| Trinity | 2,524 | 10,262 | | | 10,262 | 12,786 |
| Tuolumne | 57 | 24,930 | | | 24,930 | 24,987 |
| Yuba | 9,709 | 289 | | | 289 | 9,998 |
| Total | 39,541 | 291,896 | 864,397 | 74,611 | 1,230,904 | 1,270,445 |

Comparison of these totals for 1911 with the silver output of 1910, is as follows:

*Mine production of silver in California in 1910 and 1911, with classification of source, in fine ounces.*

| Year. | Placers. | Deep mines. | | | | Grand total. | |
|---|---|---|---|---|---|---|---|
| | | Siliceous ore. | Copper ores. | Lead ores. | Total. | Quantity. | Value. |
| 1910 | 41,856 | 257,355 | 1,363,668 | 177,206 | 1,798,229 | 1,840,085 | $993,646 |
| 1911 | 39,541 | 291,896 | 864,397 | 74,611 | 1,230,904 | 1,270,445 | 673,336 |
| Increase (+) or decrease (−) | −2,315 | +34,541 | −499,271 | −102,595 | −567,325 | −569,640 | −320,310 |

From the siliceous ore and from old tailings treated in California in 1911, the recovery of silver by amalgamation was 141,131 fine ounces, and by cyanidation, 52,756 fine ounces.

## COPPER.

The mine production of copper in California in 1911 was 36,316,136 pounds, valued at $4,539,517, a decrease of 12,384,620 pounds in quantity and $1,645,479 in value. Copper was produced in the counties of Amador, Calaveras, Inyo, Kern, Madera, Mariposa, Plumas, Riverside, San Bernardino, and Shasta. The heaviest production, as is always the case, was from Shasta County, but smelter-fume litigation and the enforced closing of mines and works reduced the output from 40,397,284 pounds in 1910 to 29,618,032 pounds in 1911. In 1909 the county produced 50,013,511 pounds of copper, so it may be noted that the output is rapidly falling off. The next county in importance in copper production was Calaveras, followed in the order named by San Bernardino, Amador, Kern, Inyo, and Madera. There were 30 mines producing copper in California in 1911. Altogether 494,281 tons of copper ore were treated in California in 1911, which was 222,404 tons less than in 1910; and in 1910 there were 123,673 tons less than in 1909. The copper ore in California in 1911, which, as stated above, yielded 36,316,136 pounds of copper, also yielded 20,694.28 fine ounces of gold, valued at $427,789, and 864,397 ounces of silver, valued at $458,130. The total yield from copper ore alone in California in 1911 in copper, gold, and silver, was $5,425,436, or $2,154,229 less than in 1910; in 1910 it was $1,345,516 less than in 1909.

## LEAD.

The lead production of California in 1911 was 1,398,111 pounds, valued at $62,915, which is a decrease of 1,472,866 pounds, valued at $63,408, as compared with 1910. By far the larger proportion of the lead was derived from Inyo County, although small quantities came from mines in Mono and San Bernardino counties. From the lead ore were obtained also 328.86 fine ounces of gold, valued at $6,798, and 74,611 ounces of silver, valued at $39,544. The total yield of the lead industry in 1911 in California in lead, gold, and silver, amounted in value to $109,257; but $6,544 of the lead value came from siliceous ore, so that the actual value of all metals in the lead

ores was $102,713. The reason for the marked falling off in lead product, and associated metals, in 1911, is plainly seen when it is noted that two of the largest properties in Inyo County, which made a combined output of over 2,000,000 pounds of lead in 1910, were not operated in 1911.

### ZINC.

There was no production of zinc in California in 1910, but in 1911 the output was 2,807,035 pounds, valued at $160,001. The larger part of this was derived from Inyo County, although some was also produced in San Bernardino County. The zinc carbonate ore from these mines was not treated in California but was shipped to smelters in Kansas and Oklahoma.

### MINING INDUSTRY IN CALIFORNIA IN 1911.

The total value of gold, silver, copper, lead, and zinc produced in California in 1911 shows a decrease of $1,845,728 as compared with 1910, and in 1910 there was a decrease in total value of $1,820,645 as compared with 1909. This may be almost entirely attributed to curtailed operations or absolute cessation of work at certain important copper mines, formerly large producers of gold, silver, and copper. This condition has been brought about by injunctions due to litigation on the subject of damage by smelter fumes. The value of the output from copper ores in gold, silver, and copper in California in 1911 was $2,154,229 less than in 1910, and in 1910 it was $1,345,516 less than in 1909. In gold output from copper ores there was $230,499 less in 1911 as compared with 1910; in copper, $1,645,479; and in silver a decrease of 494,281 ounces. Thus it may be seen that while the copper ores were responsible for a decrease in gold, silver, and copper amounting to $2,154,229 in 1911, and that the value of the lead output was also less, the gold and zinc mines partly made up for the loss, by gaining in value the sum of $308,501, so that the total decrease for the State's output in the year 1911 was $1,845,728. The falling off in gold yield in deep mine operations in Shasta, Nevada, Mono, Mariposa, Kern, Eldorado, Lassen, and Calaveras counties was not overcome by the increased yield from the same source in the counties of Amador, Inyo, Modoc, Plumas, San Bernardino, Sierra, and notably, Tuolumne; so that the deep mines produced $74,264 less gold in 1911 than they did in 1910. In the placer mines the reduction in yield from dredging in Butte and Yuba counties of $345,210 was much more than made up by the increase of $435,477 in dredge mining in Sacramento County. Altogether the dredges in all the counties increased their total gold output for the year by $116,207, although aside from Sacramento, Calaveras, and Placer counties, many of the counties showed a falling off in gold yield from this source. There was an increase of $96,087 in value of gold and silver produced by the placer mines of California in 1911, and a decrease of $392,929 in value of gold and silver from the deep mines of all classes, a total falling off in these metals of $296,842.

The condition of the copper-mining industry has very materially affected the gross output of what has been for some years the most productive county in the State, Shasta. In 1910 that county made a total yield of gold, silver, and copper of $7,313,097 in value, but in 1911 the total value was only $5,149,126, so the decrease in values in that county alone for the year, for the reasons stated, was

$2,163,971. Moreover, in some other counties where copper operations are being carried on, litigation against the smelters has commenced or is threatened. In addition to this the most important custom smelter on the Pacific coast has, after prolonged litigation over damage by smelter fumes, been enjoined by the courts from further operations under present conditions. Pending the decision of higher courts large sums have been expended by the smelter company in installing preventive appliances, but even after this, a rehearing was denied. The works are still (1912) in operation, however, in the hope that some sort of compromise may be effected between the litigants or a remedy for the cause of complaint provided.

The relative percentage of output of gold from placer and deep mine operations in California shows no very material change. As previously stated the total output of gold from dredging continues to increase. The larger fields in Butte and Yuba counties are apparently decreasing in yield, while that in Sacramento County is very materially increasing its output. The same may be said of Calaveras and Placer counties. In Butte County there are now 30 dredges at work, in Sacramento County, 10; in Yuba, 13; in Calaveras, 4; and in Siskiyou and Placer, 2 each. The counties of Merced, Stanislaus, Shasta, and Trinity have 1 dredge each. In the tables accompanying this chapter these four last-named counties are combined as to dredging figures, in order to conceal individual output of the dredging companies. In Merced and Stanislaus counties there are no other mines except the two dredge companies, but in both Shasta and Trinity counties, all placers with the exception of the two single dredges, are accounted for in the tables after the separate names of the counties. In this way neither Shasta nor Trinity get full credit for their placer output, since that of the dredges is combined under the names of Merced, Stanislaus, Shasta, and Trinity. It was impossible to follow any other course without revealing the individual production of these single dredges in these counties.

In the section on production by counties in this report the details of deep-mining work in the Mother Lode counties are given. A condensed statement of the record of these Mother Lode counties is given in the following table:

*Tonnage of ore and value recovered in bullion in gold and silver mills, tonnage and value of concentrates produced, and total recovery, with average value per ton, in Mother Lode counties, California, 1911.*

| County. | Ore to gold and silver mills. | | | | Concentrates produced. | | | | Value of total recovery. | Value of total average recovery per ton. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Gold in bullion. | Silver in bullion. | Average value in gold and silver recovered on plates per ton. | Quantity. | Gold. | Silver. | Average value in gold and silver per ton. | | |
| | *Short tons.* | | *Fine ounces.* | | *Short tons.* | | *Fine ounces.* | | | |
| Amador.... | 621,122 | $1,815,223 | 25,111 | $2.94 | 13,436 | $942,926 | 8,534 | $70.51 | $2,775,981 | $4.47 |
| Calaveras.. | 417,905 | 425,200 | 6,510 | 1.03 | 8,933 | 368,251 | 8,678 | 41.74 | 801,501 | 1.92 |
| Eldorado .. | 11,438 | 48,760 | 900 | 4.30 | 213 | 13,926 | 201 | 65.89 | 63,270 | 5.53 |
| Mariposa... | 18,116 | 156,126 | 1,896 | 8.67 | 401 | 13,331 | 523 | 33.94 | 170,739 | 9.42 |
| Tuolumne.. | 308,503 | 637,106 | 17,911 | 2.10 | 10,867 | 448,556 | 7,004 | 41.62 | 1,098,867 | 3.56 |
| Total.. | 1,377,084 | 3,082,415 | 52,328 | 2.26 | 33,850 | 1,786,990 | 24,940 | 50.74 | 4,910,358 | 3.57 |

A comparison of this table with the corresponding one for the year 1910 shows a total increase of tonnage milled in the five combined Mother Lode counties in 1911 of 206,587 tons, and an increase in total output of gold and silver of $474,556. The average value of gold and silver recovered on the plates in the mills in 1911 was 21 cents less per ton than in 1910; the average value in gold and silver of the concentrates was $3.81 less per ton; and the value of the total average recovery per ton was 21 cents per ton lower. The increased tonnage is accounted for by larger output of ore in Amador, Calaveras, and Tuolumne counties, the other two Mother Lode counties showing a falling off.

The quantity of ore treated from the deep mines of the State in 1911 was 2,797,261 tons, or 99,376 tons more than in 1910. The Mother Lode counties contributed largely to this increase. In view of the great decrease of ore output in Shasta County for the reasons previously stated, Amador County now holds the record for largest ore production, 656,806 tons. It holds also the record for largest production of gold from deep mines for 1911.

The total tonnage, by kinds of ore treated or sold in each county of California in 1911, is shown in the following table:

*Subdivision of tonnage of crude ore sold or treated in California in 1911, by counties, in short tons.*

| County. | Siliceous ores. | Copper ores. | Lead ores. | Zinc ores. | Total ore. |
|---|---|---|---|---|---|
| Amador | 654,725 | 2,081 | ..... | ..... | 656,806 |
| Butte | 2,575 | ..... | ..... | ..... | 2,575 |
| Calaveras | 422,095 | 60,888 | ..... | ..... | 482,983 |
| Colusa and Lassen | 522 | ..... | ..... | ..... | 522 |
| Eldorado | 11,444 | ..... | ..... | ..... | 11,444 |
| Fresno | 1,515 | ..... | ..... | ..... | 1,515 |
| Humboldt | 70 | ..... | ..... | ..... | 70 |
| Imperial and San Diego | 23,181 | ..... | ..... | ..... | 23,181 |
| Inyo | 95,522 | 21 | 1,759 | 4,360 | 101,662 |
| Kern | 180,647 | 40 | ..... | ..... | 180,687 |
| Madera | 226 | 84 | ..... | ..... | 310 |
| Mariposa | 18,156 | 40 | ..... | ..... | 18,196 |
| Modoc | 1,186 | ..... | ..... | ..... | 1,186 |
| Mono | 33,375 | ..... | 94 | ..... | 33,469 |
| Nevada | 263,062 | ..... | ..... | ..... | 263,062 |
| Placer | 6,181 | ..... | ..... | ..... | 6,181 |
| Plumas | 47,470 | ..... | ..... | ..... | 47,470 |
| Riverside and Los Angeles | 4,815 | 60 | ..... | ..... | 4,875 |
| San Bernardino | 8,569 | 9,201 | 155 | 265 | 18,190 |
| Shasta | 98,929 | 421,866 | ..... | ..... | 520,795 |
| Sierra | 35,360 | ..... | ..... | ..... | 35,360 |
| Siskiyou | 9,747 | ..... | ..... | ..... | 9,747 |
| Trinity | 67,925 | ..... | ..... | ..... | 67,925 |
| Tuolumne | 308,652 | ..... | ..... | ..... | 308,652 |
| Yuba | 398 | ..... | ..... | ..... | 398 |
| Total | 2,296,347 | 494,281 | 2,008 | 4,625 | 2,797,261 |
| Increase (+) or decrease (−) | +333,051 | −222,404 | −15,896 | +4,625 | +99,376 |
| Average value per ton in gold and silver | $4.57 | $1.79 | $23.08 | ..... | ..... |

The subdivision of tonnage and production of gold and silver in California in 1911, according to methods of treatment, is shown in the table following.

*Subdivision of tonnage and production of gold and silver in California in 1911, according to methods of treatment, by counties.*

| County. | Ore to gold and silver mills. | | | Concentrates produced. | | |
|---|---|---|---|---|---|---|
| | Tonnage. | Gold. | Silver. | Tonnage. | Gold. | Silver. |
| | | | *Fine ozs.* | | | *Fine ozs.* |
| Amador | 621,122 | $1,815,223 | 25,111 | 13,436 | $942,926 | 8,534 |
| Butte | 2,575 | 11,654 | 574 | 1 | 120 | 30 |
| Calaveras | 417,905 | 425,200 | 6,510 | 8,933 | 368,251 | 8,678 |
| Colusa and Lassen | 522 | 2,837 | 530 | ..... | ..... | ..... |
| Eldorado | 11,438 | 48,760 | 900 | 213 | 13,926 | 201 |
| Fresno | 1,515 | 16,429 | 143 | 2 | 300 | 2 |
| Humboldt | 70 | 905 | 27 | ..... | ..... | ..... |
| Imperial and San Diego | 23,181 | 97,885 | 357 | ..... | ..... | ..... |
| Inyo | 65,256 | 489,733 | 13,923 | 67 | 8,157 | 462 |
| Kern | 179,257 | 539,169 | 8,659 | 14 | 952 | 662 |
| Madera | 226 | 1,958 | 91 | ..... | ..... | ..... |
| Mariposa | 18,116 | 156,126 | 1,896 | 401 | 13,331 | 523 |
| Modoc | 1,186 | 19,875 | 685 | ..... | ..... | ..... |
| Mono | 13,705 | 203,190 | 7,088 | ..... | ..... | ..... |
| Nevada | 263,054 | 1,978,756 | 23,323 | 5,207 | 173,556 | 5,854 |
| Placer | 6,181 | 33,275 | 732 | 99 | 4,983 | 2,045 |
| Plumas | 44,192 | 141,436 | 1,206 | 127 | 16,497 | 424 |
| Riverside and Los Angeles | 715 | 6,581 | 3,831 | ..... | ..... | ..... |
| San Bernardino | 2,171 | 23,770 | 810 | ..... | ..... | ..... |
| Shasta | 63,420 | 588,740 | 6,459 | 352 | 33,788 | 579 |
| Sierra | 34,921 | 235,263 | 8,692 | 412 | 21,594 | 406 |
| Siskiyou | 9,447 | 101,081 | 2,089 | 5 | 2,658 | 22 |
| Trinity | 67,885 | 288,658 | 10,045 | 21 | 3,346 | 40 |
| Tuolumne | 308,503 | 637,106 | 17,911 | 10,867 | 448,556 | 7,004 |
| Yuba | 387 | 4,785 | 155 | ..... | ..... | ..... |
| Total | 2,156,950 | 7,868,365 | 141,747 | 40,157 | 2,052,941 | 35,466 |
| Average value per ton | ..... | $3.65 | $0.03 | ..... | $51.12 | $0.46 |

| County. | Crude ore to smelters. | | | Old tailings treated. | | |
|---|---|---|---|---|---|---|
| | Tonnage. | Gold. | Silver. | Tonnage. | Gold. | Silver. |
| | | | *Fine ozs.* | | | *Fine ozs.* |
| Amador | 2,081 | $14,324 | 19,951 | 33,603 | $34,791 | 753 |
| Butte | ..... | ..... | ..... | ..... | ..... | ..... |
| Calaveras | 60,888 | 69,770 | 107,988 | 4,190 | 4,430 | 1,594 |
| Colusa and Lassen | ..... | ..... | ..... | ..... | ..... | ..... |
| Eldorado | 6 | 750 | 10 | ..... | ..... | ..... |
| Fresno | ..... | ..... | ..... | ..... | ..... | ..... |
| Humboldt | ..... | ..... | ..... | ..... | ..... | ..... |
| Imperial and San Diego | ..... | ..... | ..... | ..... | ..... | ..... |
| Inyo | 6,465 | 19,844 | 68,804 | 29,941 | 57,211 | 2,996 |
| Kern | 130 | 7,623 | 1,528 | 1,300 | 6,200 | 113 |
| Madera | 84 | ..... | 54 | ..... | ..... | ..... |
| Mariposa | 40 | 434 | 179 | 40 | 145 | 4 |
| Modoc | ..... | ..... | ..... | ..... | ..... | ..... |
| Mono | 103 | 379 | 17,860 | 19,661 | 57,663 | 42,048 |
| Nevada | 8 | 1,375 | 10 | ..... | ..... | ..... |
| Placer | ..... | ..... | ..... | ..... | ..... | ..... |
| Plumas | 278 | 786 | 34 | 3,000 | 582 | 8 |
| Riverside and Los Angeles | 60 | 1,392 | 28 | 4,100 | 12,650 | 143 |
| San Bernardino | 10,698 | 90,079 | 65,583 | 5,321 | 12,712 | 664 |
| Shasta | 457,322 | 425,455 | 722,132 | 53 | 380 | 860 |
| Sierra | ..... | ..... | ..... | 439 | 878 | 2 |
| Siskiyou | ..... | ..... | ..... | 300 | 750 | 19 |
| Trinity | 40 | 5,896 | 177 | ..... | ..... | ..... |
| Tuolumne | ..... | ..... | ..... | 149 | 1,188 | 15 |
| Yuba | 11 | 3,388 | 134 | ..... | ..... | ..... |
| Total | 538,214 | 641,495 | 1,004,472 | 102,097 | 189,580 | 49,219 |
| Average value per ton | ..... | $1.19 | $1.00 | ..... | $1.86 | $0.11 |

Average recovery per ton from bullion and concentrates: Gold, $4.60; silver, $0.04.

Reports were received from 1,181 producing mines in California in 1911, as shown in the following table:

*Number of producing mines in California, classified by chief product in 1911, by counties.*

| County. | Placer mines. | | | | | Deep mines. | | | | | | Total mines reporting product. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hydraulic. | Dredging. | Drift. | Surface. | Total. | Gold. | Copper. | Silver. | Silver-lead and zinc. | Zinc. | Total. | |
| Amador | 2 | ..... | 10 | 5 | 17 | 32 | 1 | ..... | ..... | ..... | 33 | 50 |
| Butte | 4 | 30 | 12 | 28 | 74 | 7 | ..... | 1 | ..... | ..... | 8 | 82 |
| Calaveras | 5 | 4 | 11 | 18 | 38 | 37 | 3 | ..... | ..... | ..... | 40 | 78 |
| Colusa and Lassen | ..... | ..... | ..... | ..... | ..... | 3 | ..... | ..... | ..... | ..... | 3 | 3 |
| Del Norte | 3 | ..... | ..... | 4 | 7 | ..... | ..... | ..... | ..... | ..... | ..... | 7 |
| Eldorado | 1 | ..... | 13 | 17 | 31 | 25 | ..... | ..... | ..... | ..... | 25 | 56 |
| Fresno | ..... | ..... | 1 | 1 | 2 | 5 | ..... | ..... | ..... | ..... | 5 | 7 |
| Humboldt | 17 | ..... | ..... | 1 | 18 | 2 | ..... | ..... | ..... | ..... | 2 | 20 |
| Imperial and San Diego | ..... | ..... | ..... | ..... | ..... | 3 | ..... | ..... | ..... | ..... | 3 | 3 |
| Inyo | ..... | ..... | ..... | ..... | ..... | 24 | 3 | 2 | 21 | 1 | 50 | 50 |
| Kern | 1 | ..... | 1 | 2 | 4 | 47 | 1 | 1 | ..... | ..... | 49 | 53 |
| Madera | ..... | ..... | ..... | ..... | ..... | 5 | 2 | ..... | ..... | ..... | 7 | 7 |
| Mariposa | ..... | ..... | ..... | 3 | 3 | 27 | 2 | ..... | ..... | ..... | 29 | 32 |
| Merced and Stanislaus | ..... | 2 | ..... | ..... | 2 | ..... | ..... | ..... | ..... | ..... | ..... | 2 |
| Modoc | ..... | ..... | ..... | ..... | ..... | 3 | ..... | ..... | ..... | ..... | 3 | 3 |
| Mono | ..... | ..... | ..... | ..... | ..... | 9 | ..... | 1 | 3 | ..... | 13 | 13 |
| Nevada | 1 | ..... | 4 | 3 | 8 | 36 | ..... | ..... | ..... | ..... | 36 | 44 |
| Placer | 1 | 2 | 46 | 20 | 69 | 13 | ..... | ..... | ..... | ..... | 13 | 82 |
| Plumas | 5 | ..... | 8 | 25 | 38 | 15 | ..... | ..... | ..... | ..... | 15 | 53 |
| Riverside | ..... | ..... | ..... | ..... | ..... | 6 | 1 | ..... | ..... | ..... | 7 | 7 |
| Sacramento | ..... | 10 | 1 | ..... | 11 | ..... | ..... | ..... | ..... | ..... | ..... | 11 |
| San Bernardino | ..... | ..... | ..... | 1 | 1 | 26 | 14 | 5 | 9 | 1 | 54 | 55 |
| Shasta | ..... | 1 | 1 | 8 | 10 | 49 | 3 | 1 | ..... | ..... | 53 | 63 |
| Sierra | 6 | ..... | 18 | 12 | 36 | 26 | ..... | ..... | ..... | ..... | 26 | 62 |
| Siskiyou | 77 | 2 | 9 | 29 | 117 | 39 | ..... | ..... | ..... | ..... | 39 | 156 |
| Trinity | 46 | 1 | ..... | 11 | 58 | 24 | ..... | ..... | ..... | ..... | 24 | 82 |
| Tuolumne | ..... | ..... | 6 | 2 | 8 | 55 | ..... | ..... | ..... | ..... | 55 | 63 |
| Yuba | ..... | 13 | ..... | 20 | 33 | 4 | ..... | ..... | ..... | ..... | 4 | 37 |
| Total | 169 | 65 | 141 | 210 | 585 | 522 | 30 | 11 | 33 | 2 | 596 | 1,181 |

## PRODUCTION BY COUNTIES.

### AMADOR COUNTY.

The most productive of the Mother Lode counties in California is Amador.

*Mine production of Amador County, Cal., in 1910 and 1911.*

| Year. | Gold. | | Silver. | | Copper. | | Total. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ozs.* | | *Fine ozs.* | | *Pounds.* | | |
| 1910 | 128,012.16 | $2,646,246 | 36,883 | $19,917 | 151,480 | $19,238 | $2,685,401 |
| 1911 | 137,017.11 | 2,832,395 | 54,526 | 28,899 | 227,848 | 28,481 | 2,889,775 |
| Increase (+) | +9,004.95 | +186,149 | +17,643 | +8,982 | +76,368 | +9,243 | +204,374 |

In 1910 the value of the output of Amador County was increased over that of 1909 by $355,096, so that in two years there has been an increase in value of output of $559,470. This increase has been almost entirely due to the success attending the very deep mining operations on the more extensive mines of the Mother Lode in this county and may be considered a matter of great encouragement to the owners of Mother Lode properties in other counties where devel-

opments have not been carried on to so great a depth or extent. The increase in 1911 was not only in gold but in silver and copper as well. There were 17 productive placer mines in the county and 33 deep mines, 50 in all. The total output of ore of the county was 656,806 tons, which was the largest in the State. There was an increase of output of 78,872 tons in 1911.

Of the total output 2,081 tons of copper ore were shipped to the smelters and 621,122 tons, or 89.7 per cent of the total tonnage, was treated in the gold and silver mills. From this milling ore $1,815,223 in gold and 25,111 ounces of silver was saved as bullion, an average gold value of $2.92 per ton and an average silver value of $0.02 per ton. The total gold and silver obtained as bullion was valued at $1,828,532, an average of $2.94 per ton. From this milling ore was obtained 13,436 tons of concentrates, which yielded $942,926 in gold, an average of $70.18 per ton, and 8,534 ounces of silver, an average of 33 cents per ton, a total average value of $70.51 per ton in gold and silver. The extraction of gold from bullion and concentrates was $2,758,149, an average of $4.43 per ton, and the recovery of silver was 33,645 ounces, an average value of $0.04 per ton. The value of the total yield of both gold and silver from milling ore was therefore $2,775,981, an average value of $4.67 per ton. The yield of the placers of the county was 1,215.71 fine ounces of gold, valued at $25,131, and 177 ounces of silver, valued at $94. Of the placers 2 were hydraulic mines, 10 drift, and 5 sluicing properties.

In 1911 the deep mines of Amador City produced 124,808 tons of ore (including 24,000 tons of tailings), which yielded $477,274 in gold and 5,611 ounces of silver, a total value of $480,248. Of these mines the Bunker Hill Consolidated has a 40-stamp mill, enlarged by 20 stamps during the year. The tailings department has a 120-ton slime-concentrating plant and an 80-ton sand-leaching cyanide plant. The concentrates from slimes are agitated in Pachuca tanks and the sands leached in tanks. This plant was enlarged by the addition of four 100-ton leaching tanks during the year. Among the other large mines at Amador City is the Original Amador, which is developed by an 800-foot vertical shaft. The mine has a 20-stamp amalgamation and concentrating mill. On the Keystone, one of the oldest mines in the State and formerly a large producer, no work was done except pumping and general repairs during 1911. At Defender the mines are all small producers. At Drytown the principal mine is the Fremont Consolidated, which includes the Gover, North Gover, Loyal, and Fremont. There are two incline shafts 1,550 and 2,000 feet, respectively. At the 40-stamp mill they crush wet under stamps, amalgamate, concentrate on Frue Vanners, treat tailings over canvas, and ship concentrates to a smelter. Near Ione the Ione Coal & Iron Co. has a vertical shaft 400 feet deep. The ore is crushed and concentrated on 3 Pindar tables and 1 Frue Vanner. The ores are sulphide and the gangue siliceous. The products—gold, silver, and copper—are sold to the smelter of the Mountain Copper Co. At Jackson and Sutter Creek, which may be considered as one district, are some of the most important mines in the State in tonnage and output. The total output of these deep mines in 1911 was 451,914 tons, yielding $2,054,081 in gold and 22,681 ounces of silver. There was also a small amount of placer gold from this district. The Argonaut at Jackson has an incline shaft 3,872 feet deep, 198 feet of which were sunk in 1911. The mill has 40 stamps and was operated 21.3 hours

per day for 365 days in 1911. From the mine 197 tons per day were taken for 365 days. The Kennedy, which ranks second in point of gold production among the deep mines of the State, has a vertical shaft 3,555 feet deep. About 1,000 feet of drifts were run in 1911. The Zeila is not so important a producer as formerly. At Sutter Creek the Central Eureka, a well-equipped mine, is an important producer, and the South Eureka is still more important, the latter having an 80-stamp mill and a 2,415-foot vertical shaft. There are several smaller producers at this place. There are no specially important producers at Pine Grove or Plymouth.

## BUTTE COUNTY.

*Mine production in Butte County, Cal., in 1910 and 1911.*

| Year. | Gold. | | Silver. | | Lead. | | Total. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ounces.* | | *Fine ounces.* | | *Pounds.* | | |
| 1910 | 120,346.89 | $2,487,791 | 11,851 | $6,400 | 659 | $29 | $2,494,220 |
| 1911 | 112,394.28 | 2,323,396 | 9,627 | 5,102 | | | 2,328,498 |
| Decrease | −7,952.61 | −164,395 | −2,224 | −1,298 | −659 | −29 | −165,722 |

In 1911 Butte County showed a decrease in value of total production of $165,722, most of which was gold. This is much less than the falling off shown in the preceding year. The loss was mainly due to operations in the dredging fields. The productive mines of this county comprise 4 hydraulic, 30 dredge, 12 drift, 28 surface, and 8 deep mines—82 in all. The dredges produced $2,251,764 in gold in 1911, as compared with $2,389,235 in 1910. There were two less dredges in the county than in 1910, one having been dismantled and removed to Calaveras County and the other being worn out and sunk. The hydraulic mines produced $9,152 in gold in 1911, or $6,623 less than in 1910. The drift mines yielded $22,937, which was a decrease, and the surface placers $27,769, which was an increase. The total output of gold from placers of all kinds in 1911 was $2,311,622, which is $156,883 less than in 1910. The deep mines of the county produced $11,774 in gold, as compared with $19,286 in 1910. Of the three great dredging fields of the State, Oroville led in output for a number of years, but is now second in rank, being materially exceeded by the Yuba County field near Marysville. The following table shows the output of gold from the Oroville field for several years past, with the increase or decrease:

*Gold output of Oroville, Cal., dredging district, 1903–1911, with increase (+) or decrease (−), by years.*

| | | |
|---|---|---|
| 1903 | $1,329,998 | |
| 1904 | 1,632,507 | +$302,509 |
| 1905 | 2,261,887 | + 629,380 |
| 1906 | 2,768,782 | + 506,895 |
| 1907 | 2,697,092 | − 71,690 |
| 1908 | 3,043,151 | + 346,059 |
| 1909 | 2,743,232 | − 299,919 |
| 1910 | 2,099,628 | − 643,604 |
| 1911 | 1,987,294 | − 112,334 |

This table applies to the dredges at Oroville alone, there now being in Butte County 6 other dredges at work in outside districts. The combined output of these "outside" dredges in 1911 was $264,470 in gold, as compared with $289,607 in 1910 and with $147,041 in 1908.

In 1911 the following companies were operating in the Oroville field: Boston & California; Boston & Oroville; El Oro (2 dredges); Gold Run; Indiana; Natomas Consolidated of California (3 dredges); Ophir; Oroville Dredging & Exploration (3 dredges); Oro Water, Light & Power (5 dredges); Pacific (4 dredges); Pennsylvania; and Viloro Syndicate. The companies in Wyman's Ravine, Honcut, and Butte Creek districts are the Butte Creek Consolidated, Drexler, Gardella, Honcut, Kentucky, and Leggett—each with one dredge. The Drexler is a new company started in 1911. The Bucket dredge, which produced in 1910, did not produce in 1911. The Butte dredge at Oroville was dismantled and sent to Jenny Lind, Calaveras County, where it is now in operation. One of the dredges of the Oro Water, Light & Power Co. was wrecked in August, 1911. In dredging operations in Butte County there was a falling off in gold yield in 1911 as compared with 1910 of $112,334 in the Oroville field and of $25,137 in the "outside" districts, a total decrease of $137,471. This is a much better showing than was made by the county in 1910 in this industry.

As to other placer operations, the Big Butte and Robinson are drift mines at Berdan, and the Cherokee is a hydraulic mine at Cherokee. The placers at Clipper Mills, Enterprise, Inskip, Lovelock, and John Adams are all small producers. Those at Magalia are both drift and sluicing mines. There are no large operations in placer mining at Oroville outside the dredging, and no large producers at Paradise, Stirling City, or Yankee City. Of the deep mines the Crystal Peak at Enterprise has a 5-stamp mill with concentrator and canvas plant, and is developed by an 800-foot tunnel. The Phoenix at Hurleton has a triple discharge Hendy 3-stamp mill and concentrator. The Triumph at Lumpkin has a 2-stamp Hendy mill, a Beers roller mill, and Johnson concentrator. The tunnels run in on a nearly horizontal vein. The deep mines of the county only produced $11,774 in gold. Some development is going on at the old mines of Forbestown, but there was no production from that camp in 1911.

## CALAVERAS COUNTY.

*Mine production of Calaveras County, Cal., in 1910 and 1911.*

| Year. | Gold. | | Silver. | | Copper. | | Total. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ounces.* | | *Fine ounces.* | | *Pounds.* | | |
| 1910 | 55,520.23 | $1,147,705 | 155,248 | $83,834 | 7,302,331 | $927,396 | $2,158,935 |
| 1911 | 53,808.24 | 1,112,315 | 126,476 | 67,032 | 5,681,200 | 710,150 | 1,889,497 |
| Decrease (−) | −1,711.99 | −35,390 | −28,772 | −16,802 | −1,621,131 | −217,246 | −269,438 |

The gold output of Calaveras County in 1911 decreased by $35,390, the silver by 28,772 ounces, and the copper by 1,621,131 pounds, valued at $217,246, a total decrease in value or $269,438. In 1911

78 productive mines were reported in the county, of which 40 were deep and 38 placers. Of the latter, 5 were hydraulic mines, 4 dredges, 11 drift, and 18 surface or sluicing mines. There was an increase of 7 productive mines over the number in 1910. The total ore output was 46,720 tons more than in 1911, but as far as gold and silver value of total recovery per ton is concerned the average was $1.92 in 1911, as compared with $2.23 in 1910, which accounts for the decrease in gold for the year.

The output of ore sold or treated in Calaveras County was 482,983 tons, yielding 41,972.62 fine ounces of gold, valued at $867,651, 124,770 ounces of silver, valued at $66,128, and 5,681,200 pounds of copper, valued at $710,150.

The output of placer gold was 11,835.62 fine ounces, valued at $244,664, and 1,706 ounces of silver, valued at $904.

The output of the county in 1911 in gold, silver, and copper was valued at $1,889,497.

There were 417,905 tons of ore treated at gold and silver mills, from which was obtained $425,200 gold, or $1.02 per ton, and 6,510 ounces of silver, valued at $3,451, or $0.01 per ton. The total saving in bullion was valued at $428,651, or $1.03 per ton. From this 417,905 tons, 8,933 tons of concentrates was produced, yielding $368,251 in gold and 8,678 ounces of silver, valued at $372,850, an average value of $41.23 per ton in gold and 51 cents per ton in silver, or a total average value of $41.74 per ton. The milling ore yielded $793,451 in gold, the average recovery of gold per ton being $1.89; in silver the average recovery was 2 cents per ton; the total gold and silver recovered was therefore valued a $1.91 per ton. There were 60,888 tons of smelting ore, yielding $69,770 in gold, valued at $1.15 per ton, and 107,988 ounces of silver, valued at $57,233, or $0.94 per ton, and 5,681,200 pounds of copper, valued at $710,150. The total value of this smelting ore was $837,153, or $13.75 per ton.

There were also 4,190 tons of old tailings treated, yielding in gold $4,430 and in silver 1,594 ounces, valued at $845. The average recoverable value per ton of the tailings in gold and silver was $1.26.

The principal deep producing mines of the county are at Angels, and the mines of this district produced 271,238 tons of ore in 1911, which yielded $549,552 in gold and 12,121 ounces of silver; this is a much better record than was made by the camp in 1910. The Angels mine is developed by a 2-compartment 900-foot vertical shaft and considerable development was done during 1911, including the unwatering of the lower level. The mine has a 40-stamp amalgamation and concentration mill. The Dolling Gold Mining Co. (owning the North Star, Cloud, and Gold Valley claims) has a 470-foot incline shaft and 1,940 feet of drifts and cuts. In 1911 the shaft was deepened by 270 feet, and 955 feet of drifting and crosscutting was accomplished. Thirty stamps of the new mill were completed in February, 1911, and 10 more were added in November. The mill is equipped with concentrators. The Lightner, with a 60-stamp mill, made a smaller ore production than usual, and that of a low grade, and much development work has been done by the new company owning the property in trying to expose a larger and better ore body. The Utica Co., the largest producer in the camp, operated the Utica until November, and then shut it down for lack of water, but operated the Gold Cliff the entire year. The latter mine has an incline shaft

800 feet deep, an incline winze of 800 feet, and about 1,000 feet of drifts. It is equipped with a 40-stamp amalgamating and concentrating mill. The Utica proper has a 1,400-foot vertical shaft and an incline winze of 375 feet. It is equipped with a 60-stamp amalgamating and concentrating mill. At Campo Seco the Penn Mining Co., operating a copper mine, has a shaft 1,500 feet on the incline, and this was sunk from the 1,050 to the 1,500 level in 1911. The mine is equipped with a 200-ton smelter. The 120-ton reverberatory furnace was operated the entire year and the 80-ton blast furnace was operated the first six months only. The matte produced is shipped to the American Metals Co. The Gwin, at Gwin-mine, formerly a large producer, still remains full of water and idle. At Copperopolis the Calaveras Copper Co., owning the Keystone, Empire, and Union mines, has several shafts to a depth of 800 feet, all on the same vein. The mines are equipped with a 500-ton concentrator, 250-ton smelter, including 2 roasters, 1 blast, and 1 reverberatory furnace, with 2 stands of converters. The treatment is intended to be concentration of low-grade ore, smelting concentrates in the reverberatory furnace, and the high-grade ore in blast furnaces. The concentrator was completed in June, 1912, and the smelter later in the year. At Glencoe are the Etna, Tobia, and Spring Day mines, all small producers. At Melones the Melones Mining Co. is developed by an adit 5,000 feet long on the 1,100-foot level, with an incline winze from the 1,100-foot to the 1,350-foot level. Upward of 1,400 feet of underground development work was done in 1911. The reduction plant consists of a 100-stamp amalgamating mill with Frue and Wilfley concentrators. The property was closed down for repairs for some weeks in 1911. At Milton is the Napoleon Copper mine. The Bagsby, Outlook, and Greek mines, all small producers, are at Mokelumne Hill. At Murphy the Clary Co., owning the Washington and South Fork mines, has a 10-stamp mill. The Washington only was worked in 1911. The Comet, at Railroad Flat, has a 10-stamp mill, with concentrator operated by water power; all development and equipment have taken place in this property since March, 1911. It is worked by an open-cut tunnel. The Sheep Ranch Consolidated Mining Co., at Sheep Ranch, with a 20-stamp mill, was not in operation in 1911, but some production was made from old dumps by single percolation by cyanide. At Valley Spring the Victor Mining & Leasing Co. operated the Hamby mine under lease for part of the year. The mine has a 20-stamp amalgamating and concentrating mill. At Westpoint the Gilbertson, Lightning Rod, North Star, and Nelson are small producers. In placer gold the hydraulic mines yielded $19,509 in 1911, the dredges $203,043, the drift mines $8,781, and the surface mines $13,331, a total of $244,664. The dredges of the county are operated by the Butte Dredging Co., Calaveras Dredging Co., and Isabel Gold Dredging Co. at Jenny Lind and the Calaveras Engineering Co. at San Andreas. The Butte Co. only operated a few days in 1911, having just got its machine started. This boat was moved from Butte to Calaveras County. The Calaveras Engineering Co. finished its dredging work at the Fox mine, on the South bank of Calaveras River, 3 miles south of San Andreas, in September, and expects to move its plant to another location. The mine was worked by a Lidgerwood drag-line excavator to hoist, digging gravel to bedrock.

The gold-saving plant consisted of a revolving screen and gold tables on timber skids, rolled on surface for each set-up. The gold was saved on Hungarian riffles and cocoa matting. At Mokelumne Hill the Calaveras, Gooch & Lewis, McCann, and Three B. are sluicing properties. At San Andreas are the Calaveritas hydraulic and the Chapman and Rising Star drift mines. The placers at Sheep Ranch, Vallecito, Valley Spring, and Wallace are all unimportant ones.

### COLUSA AND LASSEN COUNTIES.

In Colusa County there is only one producing mine, the Manzanita, at Sulphur Creek. In Lassen County are the Lassen, at Hayden Hill, and the Humbug, at Milford. The tonnage of the combined mines was 522 tons and the yield was $2,837 in gold, and 530 ounces of silver, the total value being $3,118.

### ELDORADO COUNTY.

Eldorado, which is one of the five Mother Lode counties in California, in 1911 produced 6,480.66 fine ounces of gold, valued at $133,957, and 1,905 ounces of silver, valued at $1,010, a total value of $134,977, or $37,294 less than in 1910. The ore mined, amounting to 11,444 tons, was all treated at gold and silver mills with the exception of 6 tons of gold ore sent to the smelter. The gold saved on the plates was $48,760, or an average of $4.26 per ton, and 900 ounces of silver, valued at $477, was recovered, the total recovery from the plates being valued at $49,237, an average value of $4.30 per ton. There were 213 tons of concentrates derived from the milling ore, which yielded $13,926 in gold and 201 ounces of silver, a total value of $14,033 in gold and silver, or $65.38 per ton in gold and $0.51 in silver per ton, an average value of $65.89 per ton in both gold and silver. The ore milled yielded, therefore, on the plates and from the concentrates, a total of $62,686 in gold, or an average per ton of $5.48, and silver valued at $584, or $0.05 per ton, or a total value of gold and silver of $63,270, or $5.53 per ton.

The placer mines of the county yielded 3,411.94 fine ounces of gold, valued at $70,531, and 794 ounces of silver, valued at $421. Of the gold, $1,100 came from 1 hydraulic mine, $63,740 from 13 drift mines, and $5,691 from 17 sluicing or surface mines. There were 56 producing mines in the county in 1911, of which 31 were placers and 25 were deep.

There are few mines of importance now operating in Eldorado County. The Good Luck, at Diamond Spring, with a 5-stamp mill, was only worked for three months under bond. The South End and Nashville has a small 2-stamp mill. The Sherman, near Placerville, has a 700-foot deep incline shaft and drift 700 feet, and is equipped with a 10-stamp amalgamating and concentrating mill. Smaller producers among the quartz mines are at Coloma, Diamond Spring, Georgetown, Greenwood, Josephine, Nashville, Placerville, and Rescue. The more important placers are the Ensley and Michigan, at Fairplay; Watson drift, at Georgetown; Eureka hydraulic, at Josephine; Hope Mining Co. (Landecker) drift and Excelsior drift, at Placerville; and Kumfa-Carpenter drift, at Smith Flat.

### DEL NORTE AND HUMBOLDT COUNTIES.

The only productive mines in Del Norte County are placers, of which 3 are hydraulic and 4 surface. These mines in 1911 yielded $1,743 in gold and 13 ounces of silver, with a total value of $1,750. This is a small falling off from the production of 1910.

The production of Humboldt County from 18 placers and 2 deep mines was $35,135, of which the gold amounted to 1,691.48 fine ounces, valued at $34,966, and, the silver to 319 ounces. This result shows a small decrease from the yield of 1910. The deep mines are the Doney-Camp Pedro and Red Cap, at Orleans, both small producers. Virtually all the placers are hydraulic mines, and, with the exception of a few at China Flat and Weitchpec, they are all at Orleans. The chief producer is the California Mining & Dredging Syndicate, which is hydraulicking its gravel. Other producers of note are the Croton Bar, Pearch, and Rosalina, at Orleans, and the Klamath, at Weitchpec. The water season was rather short with all these mines in 1911, there only being a few months of actual mining.

### FRESNO COUNTY.

The production in Fresno County in 1911 in gold and silver was $17,522, of which $17,441 was gold, with 153 ounces of silver. There was no copper production in 1911, as there was in 1910, so the total valuation of the output of the county was $50,752 less than in 1910. In 1909 the county output was valued at $218,263, which shows how the discontinuance of copper mining has affected the annual output. However, in gold yield in 1911 the county shows an increase of $14,068. The silver yield was 5,717 ounces in 1910, as compared with 153 ounces in 1911. The value of the copper production was $61,814 in 1910. There were only 2 placers and 5 deep mines producing in 1911. The placers are at Friant; the deep mines are at Dunlap, Friant, Pine Ridge, and Kings River. The Eliza Jane, at Kings River, is the only producer of much importance in the county. It is worked through a 400-foot tunnel and an 80-foot shaft. The reduction plant consists of a Huntington mill. A cyanide plant for treating tailings was put in during 1911.

### IMPERIAL AND SAN DIEGO COUNTIES.

There were only 3 deep mines producing in Imperial and San Diego counties in 1911, and no placers. Their total output in 1911 was valued at $98,044, of which $97,855 was for gold and $1,189 was for 357 ounces of silver. The only important property is that of the United Mines Co., at Ogilby, where the Golden Cross and Golden Crown mines were operated for five months of the year and then closed down for reorganization. The Golden Cross incline shaft is 1,270 feet deep, and several hundred feet of drifts and winzes were cut in 1911. The mines have a 50-stamp amalgamation mill, and the construction of a cyanide plant was begun during the latter part of the working period.

## INYO COUNTY.

*Mine production in Inyo County, Cal., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+), decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 19,761.62 | $408,509 | 27,812.96 | $574,945 | + 8,051.34 | +$166,436 |
| Silver.....do.... | 239,982 | 129,590 | 86,185 | 45,678 | − 153,797 | − 83,912 |
| Copper.....pounds.. | 58,047 | 7,372 | 29,504 | 3,688 | − 28,543 | − 3,684 |
| Lead.....do.... | 2,866,894 | 126,143 | 1,329,756 | 59,839 | −1,537,138 | − 66,304 |
| Zinc.....do.... | ..... | ..... | 2,624,719 | 149,609 | +2,624,719 | + 149,609 |
| Total..... | ..... | 671,614 | ..... | 833,759 | ..... | + 162,145 |

There were 50 productive deep mines in Inyo County in 1911, but no placers. Of the deep mines 24 were gold, 3 copper, 2 silver, 20 silver and lead, and 1 zinc. The total value of the output was $833,759, which is $162,145 in excess of that of 1910. There was an increase of $166,436 in gold, but the silver production decreased by 153,797 ounces in quantity and $83,912 in value, the copper by 28,543 pounds in quantity and $3,684 in value, the lead by 1,537,138 pounds in quantity and $66,304 in value. The output of zinc increased 2,624,719 pounds and $149,609 in value, there being no reported production in 1910. There were treated in 1911 in Inyo County 101,662 short tons of ore, of which 95,522 tons were siliceous, 21 tons were copper ore, 1,759 tons were lead ores, and 4,360 tons were zinc ores. The deep mines in 1911 yielded 27,812.96 fine ounces of gold, valued at $574,945. The silver yield was 86,185 ounces, valued at $45,678. Of gold, 27,557.11 fine ounces, valued at $569,656 were obtained from the siliceous ore; from copper ores were obtained 16.78 fine ounces, valued at $347, and the lead ores yielded 239.07 fine ounces, valued at $4,942. The zinc ores did not yield any gold or silver. The silver production from the siliceous ore was 28,545 fine ounces, valued at $15,129; from the copper ore 1,551 ounces, valued at $822; and from the lead ores 56,089 ounces, valued at $29,727. The siliceous ore yielded, therefore, $584,785 in gold and silver, the copper ores yielded $1,169, and the lead ores $34,669, a total of $620,623 in gold and silver for the county. The few producing mines at Ballarat are unimportant. The Golden Star at Arondo, which has its nearest post office at Searles, is an important property having two shafts of 250 and 300 feet and about 9,000 feet of drifts. During 1911 a new shaft 300 feet deep was sunk and 4,000 feet of drifts run. New machinery was also added to the mill, and a new hoist, pump, and pipe line put in. Crushers and rolls are used for reduction of the ore, which is treated in an 80-ton cyanide plant. The Monster mine at Big Pine supplies ore carrying lead, copper, gold, and silver to the smelter, having no reduction plant. The Bishop Creek Milling Co., at Bishop, did considerable development work during the year and made some small shipments pending completion of its new 10-stamp mill. The California mine at Darwin has a 5-stamp mill, concentrator, and cyanide plant. The Lucky Jim supplies its ore to a Salt Lake smelter. The ore of the Yucca Tree at Darwin is milled. The Darwin at

Independence was a producer The Reward Consolidated at Independence supplies ore carrying gold, silver, copper, and lead to the smelter. During the year both mine and plant were overhauled, and a 4½-mile electric transmission line was constructed across Owens Valley, connecting with that of the Los Angeles Aqueduct. The output of the Domingo mine at Keeler is mainly lead and silver. Large shipments to smelters at Salt Lake of lead-silver ore were made by the Four Metals Mining Co. of Keeler. The 100-ton smelter of this company at Keeler was idle. One of the mines of the company under lease supplied zinc ore to Neodesha, Kans. The Santa Rosa furnished lead-silver ores to Salt Lake City smelters. The total value of the gold, silver, copper, lead, and zinc produced by the mines at and near Keeler in 1911 was $232,878, making it the most productive district in the county, slightly exceeding Skidoo. At Lone Pine the few producers are small. The Skidoo mines, the largest single producer in Inyo County, are equipped with a 15-stamp mill and 75-ton cyanide plant. They have discontinued concentrating their ore. The Silver Rule at Tecopa supplies silver-lead ore to Salt Lake and San Francisco smelters. The Keane Wonder, the nearest post office to which is Rhyolite, Nev., has a 20-stamp mill and an 80-ton cyanide plant. The mine is one of the largest producers in the county. The Tecopa Consolidated, formerly a large producer, was not in operation in 1911.

## KERN COUNTY.

*Mine production of Kern County, Cal., in 1910 and 1911.*

| Year. | Gold. | | Silver. | | Copper. | | Lead. | | Total. |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ozs.* | | *Fine ozs.* | | *Pounds.* | | *Pounds.* | | |
| 1910 | 29,991.24 | $619,974 | 64,891 | $35,041 | ..... | ..... | 569 | $25 | $655,040 |
| 1911 | 26,967.66 | 557,471 | 11,005 | 5,833 | 33,224 | $4,153 | 600 | 27 | 567,484 |
| Increase (+) or decrease (−).. | −3,023.58 | −62,503 | −53,886 | −29,208 | +33,224 | +4,153 | +31 | +2 | −87,556 |

The gold output of Kern County was $557,471 in 1911, or $62,503 less than in 1910, and the silver output was 11,005 fine ounces, valued at $5,833, a decrease of 53,886 fine ounces in quantity and of $29,208 in value. There was a nominal output of lead in 1911, as in 1910 and also a production of 33,224 pounds of copper, valued at $4,153, which was an increase, as there was no production of copper in the county in 1910. There were 49 deep mines producing and 4 placers. These placers, at Isabella, Ricardo, and Weldon, made a combined yield of 170.62 fine ounces of gold, valued at $3,527, and 43 ounces of silver, valued at $23. There were treated 180,647 tons of siliceous ore, of which 70 tons were crude ore sent to the smelter and 1,300 tons were tailings. Besides this there were 40 tons of copper ore sent to the smelters, making a total output of 180,687 short tons. The yield in bullion from the 179,257 tons of ore to gold and silver mills was $539,169, or $3.01 per ton in average value, and 8,659 ounces of silver, making a total bullion value of $543,758 in gold and silver, with an average value per ton of $3.03. From

this ore was derived 14 tons of concentrates, yielding $952 in gold and 662 fine ounces silver, making a total value of $1,303, with an average of $93.07 in gold and silver per ton. The 130 tons of ore sent to the smelter yielded $7,623 in gold and 1,528 ounces of silver, making a total of $8,433, with an average value of $64.87 in gold and silver per ton. From the 1,300 tons of old tailings was produced $6,200 in gold and 113 ounces in silver, a total of $6,260, or an average of $4.82 in gold and silver per ton. The total yield of the county in gold and silver from deep mines was $559,754, making an average of $3.10 per ton of ore treated.

The Randsburg district is the most productive in the county, and the mines there in 1911 produced 177,732 tons of ore, yielding $505,804 in gold and 7,343 ounces of silver, valued at $3,892, a total of $509,696, as compared with a total of $525,920 in 1910. At Randsburg, the Butte Lode supplied ore to a custom smelter, and the tailings are to be cyanided. The Baltic has a 10-stamp mill and a 50-ton cyanide plant. In 1911 about 1,200 tons of ore were crushed to determine if the ore was adapted to dry crushing and direct cyanidation. The results were reported favorable, and this system is to be adopted. The Good Chance Mining Co. has a 100-ton cyanide plant and added a dry crusher during the year. Ore from the Gold Brick was crushed at a custom mill. The Santa Ana Mines Co. owns the Napoleon, Santa Ana, and Yucca Tree mines. The Orphan Girl or Gold Dollar has a 5-stamp mill. The Buckboard and Phoenix mines, owned by the Phoenix Development Co., had their ores worked at the Phoenix mill. The Yellow Aster, the most important producer in Kern County, has one mill of 100 stamps and another of 30 stamps. The mine is now being worked entirely by the quarry system. During the larger portion of the year there was trouble from a large slide of waste coming into the "glory hole," which interfered greatly with the output of ore and bullion. The Windy mine, at the same place, a large producer, supplies ore to custom mills.

The quartz mines at Amalie are all small. At Bodfish the Glen Olive was equipped with a new 5-stamp mill in 1911, which had a two months' run. The Sharpe Mines Co., at the same place, only used its 5-stamp mill and vanner a few months. At Havilah the King Solomon has a 5-stamp mill, built new in 1911. The Mammoth Mountain Co. at Isabella has a 10-stamp mill. The Old Keyes mine, at this same place, is being worked productively. The entire output of the mines near Isabella was $17,455 in gold in 1911, with a nominal output of silver. The Zenda, at Paris, is equipped with a 10-stamp mill, with concentrators and cyanide plant, but the mine was only worked three months in 1911. The few mines at Piute show a falling off in yield in 1911. The Grizzly mine at White River is equipped with a 5-stamp mill, to which a concentrator was added during the year. Certain high-grade ore mined during the year was shipped to the Selby smelter. The few placers in the county are at Isabella, Ricardo, and Weldon.

### MADERA COUNTY.

The deep mines of Madera County (there being no productive placers) made in 1911 a production of 310 tons of ore, yielding $1,958 in gold, 145 ounces of silver, and 24,488 pounds of copper, with a total valuation of $5,096. The copper yield in 1910 was 298,898

pounds. The decrease in total output in the county for 1911 was $44,780. The largest producer was the Mount Raymond at Raymond, a copper mine. The Westfall, at Fresno Flats; Madera Consolidated, at Grub Gulch; Markle Bros., Mud Springs, and Quartz Mountain, at O'Neals; Barnett (copper), at Raymond, are all small producers. The county decreased its gold yield in 1911 by $8,118 as compared with 1910, although there were 7 mines worked in 1911 as compared with 5 in 1910. The Buchanan, at O'Neals, was the largest producer in gold, silver, and copper in 1910, but it was not in operation in 1911, and the pumps and machinery have been withdrawn from the mine.

### MARIPOSA COUNTY.

Mariposa, one of the Mother Lode counties of California, produced in 1911 gold and silver valued at $173,922, or $146,022 less than in 1910. The output of gold in 1911 was 8,346.23 fine ounces, valued at $172,532, and the silver output was 2,623 ounces, valued at $1,390. The placer gold output amounted to 120.74 fine ounces, valued at $2,496, and the placer silver production was 21 ounces, valued at $11. The deep mines produced 18,196 tons of ore, 40 tons of which went to the smelter; and 40 tons of old tailings were worked during the year. The 18,116 tons of ore which went to the gold and silver mills yielded $156,126 in gold as bullion, averaging $8.63 per ton, and 1,896 ounces of silver, valued at $1,005, the total gold and silver value of the mill bullion being $157,131, or an average of $8.67 per ton. From this tonnage were also derived 401 tons of concentrates which yielded $13,331 in gold and 523 ounces of silver, a total value of $13,608. The concentrates therefore yielded $33.25 in gold and $0.69 in silver per ton, an average yield of $33.94 per ton in both gold and silver. The 40 tons sent to the smelter yielded $434 in gold, 179 ounces of silver, and 13,528 pounds of copper, or an average value per ton for gold, silver, and copper of $55.50. The siliceous ore yielded on the plates and from concentrates a total value of $170,739 in gold and silver, or an average total value of ore treated of $9.42 per ton.

Thirty-two mines were productive in the county in 1911, of which 27 were deep gold mines, 2 were copper, and 3 were placers, the latter being all sluicing mines. These small placers are at Bagby, Mariposa, and Whitlock.

The Sierra Rica and King Solomon mines at Briceburg are small combined properties equipped with a 4-stamp mill. Operators at the Santa Rosa at the same place use an arrastre and do some ground sluicing of vein material. A small production of copper was made from the Green Mountain mine at Ben Hur. At Coulterville the Bondurant has a 10-stamp mill. At this place the output of the mines fell from $60,398 gold in 1910 to $23,401 in 1911. The reason for this is that the Empire pocket and the Reich pocket mines were large producers in 1910 and did nothing in 1911, and the Champion yield was much reduced in 1911. The only producers of note at Hornitos are the Mount Gaines and the Treasure mines. The mines at this place yielded $88,490 gold in 1910, but only $25,180 gold in 1911. This was owing to the fact that the Mount Gaines, the largest producer in the camp, was closed down early in the year. At Kingsley the Trujillo Mining Co. is the largest producer. Although there is only a small mill, the ore is of high grade. The most important

mines in the county are those owned on the "Mariposa Grant" by the Mariposa Commercial & Mining Co., and the fact that in 1911 these mines were not as productive as usual largely accounts for the material reduction in value of the gold output of the county. The Mountain King Mining & Milling Co., at Mountain King, a large producer, also lowered its product in 1911. It is equipped with 34 stamps with concentrators. The Austin group at Whitlock was operated only by lessees in 1911.

### MERCED, SHASTA, STANISLAUS, AND TRINITY COUNTIES.

In Merced and Stanislaus counties there are only two producers, both dredges. In Shasta and Trinity counties are many placer mines, but in each of these counties there is only one dredge. Therefore, to avoid disclosure of confidential data, the four dredges of these four counties have been combined as to their figures of output of gold and silver. The arrangement works an injustice to Shasta County inasmuch as the figures of gold product of its single dredge are not included in its total gold output, but are credited to the four combined counties named above. The same may be said of Trinity to a much smaller degree. The combined output from gold dredging operations in Merced, Shasta, Stanislaus, and Trinity counties was $307,538 in gold and 2,134 ounces of silver, valued at $1,131, a total of $308,669.

### MODOC COUNTY.

Modoc County produced in 1911 from 1,186 tons of ore, $19,875 in gold and 685 ounces of silver, valued at $363, a total of $20,238, as compared with a total of $5,513 in 1910. There were in 1911 only 3 producing mines—the Hess and the Idaho at Adin and the Fort Bidwell at Fort Bidwell. The Hess has a 10-stamp mill with cyanide plant, and 10 stamps to be added; and the Fort Bidwell has 10 stamps. An aerial tram has been constructed, with new buildings, with a view to more extensive operations. There has been considerable excitement in the county since the close of the year, in view of the discoveries of high-grade ore. More or less mining property has since changed hands, and great hopes are entertained of establishing mining camps of permanent importance.

### MONO COUNTY.

In 1911 Mono County produced metal valued at $298,733, as compared with $445,115 in 1910, a decrease of $146,382. There were 13,705 tons of crude ore treated at the gold and silver mills, yielding $203,190 in gold and 7,088 ounces of silver, a total of $206,947 in gold and silver and an average value of $15.10 per ton in gold and silver. The total value of gold and silver produced from all ores in the county was $296,740, an average value of $8.96 in gold and silver per ton. The large decrease in the average value of the gold and silver in the mill and the average value of the total output is due to a large tonnage of tailings worked. The average value per ton in gold and silver of the tailings treated was $4.07. The 103 tons of smelting ore treated produced $379 in gold, 17,860 ounces of silver, and 44,289 pounds of lead, valued in all at $11,838.

The notable reduction in yield of the county in 1911 as compared with 1910 was due entirely to the materially reduced yield of the three largest producers—the Standard, Pittsburg-Liberty, and Casa Diablo companies. The Borrasca and Comanche and Kentuck show increased yields. The most important camp is Bodie, where the mines produced 28,265 tons of ore, yielding $228,919 gold and 28,604 ounces of silver. Over half the tonnage treated was in tailings. The Standard Consolidated is the most important mine at Bodie and in the county. It has 12 vertical shafts aggregating 6,750 feet and 7 adits aggregating 8,480 feet. In 1911, 8,000 feet of drifting sinking, etc., was done. All told there are about 60 miles of openings in this property. The mine is equipped with a 20-stamp amalgamating mill and a 150-ton cyanide plant. The crude ore is crushed, stamped, and amalgamated on plates only, reground in tube mills with old tailings, and the whole cyanided, slimes agitation treatment and the Butters filter being used. The company is the consolidation of a number of properties, all adjacent and worked as one mine. The gangue is siliceous and the ore is oxidized to a depth of 700 feet. The Columbia Consolidated Mines Co. has a 10-stamp mill and small cyanide plant, both idle, so the ore is not treated locally. This is a silver mine. Another silver mine at the same place is the Kentuck, which has a 5-stamp mill and a cyanide plant. Only tailings were worked in 1911.

## NEVADA COUNTY.

*Mine production of Nevada County, Cal., 1910 and 1911.*

| Year. | Gold. | | Silver. | | Total. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ozs.* | | *Fine ozs.* | | |
| 1910 | 122,557.24 | $2,533,483 | 30,566 | $16,506 | $2,549,989 |
| 1911 | 106,383.74 | 2,199,147 | 29,606 | 15,691 | 2,214,838 |
| Decrease (−) | −16,173.50 | −334,336 | −960 | −815 | −335,151 |

In Nevada County the metallic output for 1911 showed a decrease of $335,151 from that of 1910. This was owing to decreased production of both deep and placer gold, the deep mines having decreased their gold output by $213,179 and the placer mines by $121,157. The total falling off in silver output was 960 ounces in quantity and $815 in value. The tonnage treated in 1911 was 263,062 tons, as compared with 250,358 tons in 1910, an increase of 12,704 tons in 1911. There were 44 productive mines in the county in 1911, of which 36 were deep mines and 8 were placers. Of the placers 1 was hydraulic, 4 were drift, and 3 were sluicing mines. The placer gold aggregated in value $45,460, of which $8,000 was derived from hydraulic mines, $24,352 from drift, and $13,108 from sluicing properties. The deep mines produced 104,184.61 fine ounces of gold, valued at $2,153,687, and 29,187 ounces of silver, valued at $15,469, a total value of $2,169,156.

Nevada County, which has for many years held the first rank in production of gold from deep mines, was in 1910 passed by Amador County, the deep mines from which yielded $250,497 more than those

of Nevada County. In 1911 the deep mines of Amador produced $653,577 more gold than those of Nevada County.

There were 263,054 tons of siliceous ore treated at the gold and silver mills, which produced 5,207 tons of concentrates. There were also 8 tons of siliceous ore sent to the smelter in 1911. The value of the gold in the mill bullion was $1,978,756, or $7.52 per ton, and the silver output from the same source was 23,323 ounces, valued at $11,361, or $0.05 per ton. The total value of the gold and silver recovered in the mill bullion was $1,991,117, an average of $7.53 per ton. From the mill ore there was obtained 5,207 tons of concentrates, which yielded $173,556 in gold, or an average of $33.33 per ton, and 5,854 ounces of silver, valued at $3,102, or an average of $0.60 per ton. The total value of concentrates was $176,658 in gold and silver, or an average value of $33.93 per ton. From the total tonnage $2,153,687 in gold was recovered, or an average value of $8.18 per ton, and 29,187 ounces of silver, valued at $15,469, or an average value of $0.06 per ton. The value of the total gold and silver obtained as bullion and from concentrates and tailings was $2,169,156, the average of all tonnage treated being $8.24 per ton in gold and silver.

The principal quartz-mining district of Nevada County is that of Grass Valley, which includes the mines in both Grass Valley and Nevada City. The following table shows the production of Grass Valley district in 1910 and 1911:

*Value of production of Grass Valley and Nevada City quartz mines, Nevada County, Cal., in 1910 and 1911.*

| Year. | Grass Valley mines. | | | Nevada City mines. | | | Grand total. |
|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Total. | Gold. | Silver. | Total. | |
| 1910 | $2,113,499 | $13,101 | $2,126,600 | $118,688 | $1,731 | $120,419 | $2,247,019 |
| 1911 | 1,817,091 | 11,795 | 1,828,886 | 174,749 | 2,329 | 177,078 | 2,006,964 |
| Increase (+) or decrease (−) | −296,408 | −1,306 | −297,714 | +56,061 | +598 | +56,659 | −241,055 |

The Grass Valley deep mines decreased the value of their output for 1911 by $297,714, and the Nevada City mines increased their yield in the same period by $56,659. The decrease in yield from the mines of the entire district was valued at $241,055. The total output treated in the district was 225,823 tons, of which 195,672 tons came from Grass Valley mines and 30,151 from those of Nevada City. The Grass Valley quartz mines produced 74.4 per cent of the tonnage of the whole county and the mines at Nevada City 11.4 per cent, the district of Grass Valley having therefore produced 85.8 per cent of all the ores milled in Nevada County in 1911. The Grass Valley deep mines produced $1,817,091, or 84.4 per cent of the quartz gold obtained in Nevada County in 1911, and 76.2 per cent quartz silver, or 84.3 per cent of total value derived from quartz ores. The Nevada City deep mines produced $174,749, or 8.1 per cent of the quartz gold obtained in Nevada County, and 15.1 per cent of the quartz silver, or 8.2 per cent of the total value derived from quartz ores of the county.

Grass Valley district (including Grass Valley and Nevada City mines) produced 92.4 per cent of the quartz gold, and 91.3 per cent of the quartz silver, and 92 per cent of the total value derived from quartz-mining operations in Nevada County in 1911. The producing mines at Grass Valley in 1911 were the Brunswick Consolidated, Cassidy, Central Consolidated, Empire Mines, Golden Gate, Great Ironclad, North Star Mines, Prudential, Pennsylvania Consolidated, Sultana, and Union Hill Consolidated. Of these the Brunswick Consolidated has an incline shaft to the 1,250-foot level and a new vertical shaft is being sunk and is down 445 feet. In the early part of the year the work was principally on unwatering preparatory to resuming operations on the new shaft. Later, the mine was worked on the tribute system. The mine has a 20-stamp mill with concentrators. The Central Consolidated has a 700-foot incline shaft, and an adit 1,000 feet long. The mine is equipped with a 20-stamp mill, concentrator, and slime plant, the latter consisting of 12 tables 110 feet long. The Empire Mines and Investment Co. has an incline shaft 4,200 feet deep, and during the year 4,613 feet of drifts and raises were run. It has a 40-stamp mill and 150-ton cyanide plant. The Idaho-Maryland has an incline shaft 2,180 feet deep, and several miles of drifts, most of which are now inaccessible. There is a 20-stamp amalgamating mill with concentrators on the property. The North Star Mines Co. is the largest producer of gold among the mines of the State. The development work in 1911 consisted of 3,973 feet of drifts and winzes. The values produced were all from the North Star mines proper, although the company operated the Cincinnati mines at Grass Valley and also the Champion group at Nevada City, the latter for part of the year after taking it under option. The ore worked was auriferous quartz with about 2 per cent of sulphide. The company has two 40-stamp mills and two 150-ton cyanide plants. The North Star Co. consumed in 1911 in its ore-reduction plant 1,575 pounds of quicksilver and 70,400 pounds of potassium cyanide.

At this mine in 1911 the cost of mining the ore was $3.317 per ton milled; the milling cost was $0.526; the concentrating cost was $0.138; and cyaniding was $0.541. The ore milled yielded $10.74 per ton net. The yield was $13.68 per ton in 1910. The operating costs at the mine in 1911 were 27 cents per ton less than in 1910. The cost of development work was also reduced 7 cents per ton, so that the total cost for operation and development was 34 cents less per ton for 1911 than in 1910. It is probable that the company will abandon the Cincinnati Hill claim as the exploration work was disappointing. Under the option on the Champion group of mines at Nevada City, effective until July 13, 1913, much work is being done on the claims on that property, and much new machinery has been put in.

Many of the workings are filled with water, but the exploration work being done is extensive. The Prudential Mine, with a 12-stamp mill, was worked under bond in a small way only. The Pennsylvania Consolidated was operated by the Penn Mines Syndicate from May 1, 1911, to January 1, 1912. The Sultana is operated through an inclined shaft 1,805 feet deep, and has a 20-stamp mill. The Union Hill Consolidated is opened by an inclined shaft 600 feet deep. To the 10-stamp mill 10 stamps and a new compressor plant were added

during the year. The deep mine producers at Nevada City are the California-Montana, Champion, Mountaineer, Pittsburg-Gold Flat, Wedge and Austin, Zeibright, and Fairview mines. The principal group there—the Champion—was placed under bond to the North Star Mines Co. in July, 1911, up to which time certain ore was extracted and milled. The Mountaineer is developed by two incline shafts 1,200 feet and 400 feet deep, respectively. A 10-stamp mill is on the property and tributers did most of the work in 1911. The Pittsburg-Gold Flat has a shaft 1,300 feet deep and a winze 200 feet deeper. The mine has a 20-stamp amalgamation and concentration mill. The Zeibright has a 10-stamp mill. At Gaston the Erie Consolidated is worked through a 1,700-foot adit. The Gaston, a large producer, is equipped with a 40-stamp mill. There is complaint from this district that the mines are hampered by shortage of water power, since the water companies can get more for the electricity delivered in San Francisco than they can from the local mines. At Graniteville the Birchville Mining Co. did mostly dead work in 1911, as their mill was destroyed by fire in August, 1910, and was not rebuilt. The hoist has been replaced and the burned shaft repaired. At Maybert, the Yuba Consolidated made a very small output from a final clean-up. The Black Bear at Moores Flat was worked under bond during a part of the year. At North Columbia some of the mines closed down for part of the year owing to lack of water power.

The placers of Nevada County are not nearly so numerous or productive as formerly, before hydraulic mining was restricted. There is a little hydraulicking done in French Corral and Grass Valley. The Liberty Hill mine at Lowell Hill, in Bear River Canyon, could make a much larger production were not operations restricted by the laws. The largest placer producer in the county is the Golden Dream drift mine on the Yuba River, 16 miles west of Nevada City.

### PLACER COUNTY.

In 1911 Placer County produced gold and silver valued at $253,883, against $258,348 in 1910. The total gold yield in 1911 was 12,156.54 fine ounces, valued at $251,298, and the silver was 4,877 ounces, valued at $2,585. The deep mines produced from 6,181 tons of siliceous ore, 1,850.73 fine ounces of gold, valued at $38,258, and 2,777 fine ounces of silver, valued at $1,472. The placer-mine yield was 10,305.81 fine ounces of gold, valued at $213,040, and 2,100 fine ounces of silver, valued at $1,113. Of this placer gold $8,000 was derived from hydraulic mines; $146,775 from 46 drift mines; $49,639 from 2 dredges; and $8,626 from 20 sluicing operations. There were 69 placer mines and 13 deep gold mines productive in the county in 1911. The most productive deep mine in the county was the Orpheum at Ophir, which has a 10-stamp mill with concentrators. The mines around Auburn are all small producers. On the Rueblin at Last Chance considerable development work was done in 1911. A new tunnel has been started to prospect the entire property. The Consolidated Pioneer Gold Mines at Towle is opened by a 5,600-foot adit, and has a 20-stamp mill with Frue Vanner. The mill was only operated a short time in 1911. The Helester at Towle was not operated in 1911, nor was the Crater Hill at Ophir. The Herman, at Westville, formerly a large producer, did not operate its mill in 1911; the work done during the year consisted of development of the mine

and addition of new machinery. The 30-stamp mill was not operated. Of the placer mines those at Auburn, Applegate, Butcher Ranch, Colfax, and Dutch Flat were all small producers. The largest producers at Forest Hill are the El Dorado Placer Mining Co. (dredge) and the Paragon drift mine.

The total output of the placers at Forest Hill in 1911 was only $33,768, most of which came from dredging operations. At Gold Run the Indian Hill drift and the Inskip hydraulic were the largest producers. The Canyon Creek mine was idle. The mines at Iowa Hill were all drift, the principal ones being the McGeachin Placer Mining Co. and the Pine Avenue. The placer mines at Last Chance produced, in all, $43,795 in 1911, and they are all drift mines. Among the larger producers are the Frankmont, which was operated six months; the Placer Gravel Mining Co., and the Pacific Slab Consolidated, which was the largest producer. At Loomis, with the exception of the Beaver dredge, which began operations in July, 1911, the mines are all worked by the drifting system. Of the drift mines the Montezuma is the largest producer, followed by the Barton, which was operated eight months. The mines at Michigan Bluff, mainly drift, are mostly small producers, the California-Hawaiian being the largest, followed by the Imperial Mines Consolidated, and the Devil Basin. At Newcastle, Towle, and Westville there are no large producing gravel mines. What was formerly the most productive mine in Placer County—the Hidden Treasure drift, at Bullion—was idle during 1911.

### PLUMAS COUNTY.

The total yield from the mines in Plumas County in 1911 was valued at $230,076, as compared with $188,294 in 1910, an increase of $41,782. The gold production was 11,067.47 fine ounces, valued at $228,785, and the silver production was 2,123 ounces, valued at $1,125. There were 44,192 tons of siliceous ore treated at the mills, which yielded $141,436 in gold, and 1,206 ounces of silver, valued at $639. The crude ore to the mill yielded 127 tons of concentrates, which produced $16,497 in gold and 424 ounces of silver, valued at at $225. There were 278 tons of siliceous ore sent to the smelter which yielded $786 in gold and 34 ounces of silver. The average value of gold per ton was lowered considerably by 3,000 tons of tailings, which only yielded $582 in gold and 8 ounces of silver. The placer mines yielded 3,361.29 fine ounces of gold, valued at $69,484, and 451 ounces of silver, valued at $239. There were 38 producing placers and 15 producing deep gold mines. Of the former 5 were hydraulic mines, yielding $4,845 in gold; 8 drift mines, yielding $33,500 in gold; and 25 were sluicing mines, yielding $31,139 in gold. There was an increase of 5 hydraulic mines in 1911 over 1910, and both drift and surface mines increased their gold yield.

As in 1910, the principal deep-mine operations in Plumas County in 1911 were confined to the vicinity of Johnsville where 42,886 tons of ore (including 3,000 tons of tailings) were treated and yielded $135,310 in gold and a small quantity of silver. There was also a little placer gold from this point. The Four Hills mine was only operated from May 17 to October 1, and only 10 of the 20 stamps were utilized. The Jamison, the largest producer at Johnsville, was idle part of the year, owing to shortage of water for power. It has a 20-stamp mill, but the sulphides are not of sufficient value to justify

saving. The Plumas Eureka, a well-developed property worked for many years, has a 40-stamp mill. The deep mines at Quincy are the Bushman, Crescent Hill, and Crown Point, none of them large producers. At Seneca, the Seneca Co. ran its old 6-stamp mill a short time and after August added a new 10-stamp mill.

Of the placer mines of the county there are many at Belden, Buck, Crescent Mills, Eclipse, and Johnsville. At La Porte the combined placers produced $33,516 in gold in 1911. The largest producer is the Bellevue Consolidated, a drift mine, where the portal of the long tunnel is in Sierra County, and the gold is now mined from lands lying in Plumas County. This will explain why this mine is now considered as in Plumas County, whereas for years it was listed as a Sierra County mine. The Consolidated Alturas Mines Co. worked tailings left from hydraulic mining operations carried on 30 to 50 years ago. The Seneca Development Co. at Birchville is an important drift mine. The mines at Quincy, Seneca, Spanish Ranch, and Taylorsville are all operated in a small way.

### RIVERSIDE AND LOS ANGELES COUNTIES.

In these two counties combined there are only 7 mines, 6 gold, and 1 copper, with no placers. Their combined output in 1911 was $20,623 in gold, 4,002 ounces of silver, and 7,000 pounds of copper, valued at $875, a total valuation of $23,619. Of these 7 mines, only 1 is in Los Angeles County. The total tonnage of all the mines was 4,875 tons. The largest producers were the Eureka (tailings), at Blythe, and the Taylor-Sullivan, at Banning. The latter has a 5-stamp mill and a 40-ton cyanide plant. The mines at Calzona, Indio, and Perris are all small producers.

### SACRAMENTO COUNTY.

*Mine production of Sacramento County, Cal., in 1910 and 1911.*

| Year. | Gold. | | Silver. | | Total. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ounces.* | | *Fine ounces.* | | |
| 1910 | 67,573.78 | $1,396,874 | 8,530 | $4,606 | $1,401,480 |
| 1911 | 87,695.46 | 1,812,826 | 5,749 | 3,047 | 1,815,873 |
| Increase (+) or decrease (−) | +20,121.68 | +415,952 | −2,781 | −1,559 | +414,393 |

Sacramento County showed a larger increase in gold output in 1911 than any county in the State with the exception of Tuolumne. With respect to placer mining operations the increase in Sacramento County gold—$415,952—is the largest. In this county, in what is known as the Folsom field, there are 10 dredges at work, some of them of the largest capacity in the State. There was only one productive drift mine in 1911. The total gold yield of the county in 1911 was 87,695.46 fine ounces of gold, valued at $1,812,826, and 5,749 ounces of silver, valued at $3,047, a total of $1,815,873. There were two more dredges in operation in the county in 1911 than there were in 1910. In the Folsom dredging field, large sums of money have been expended in constructing works to prevent muddy water caused by dredging operations from getting into the clear waters of American River, whence the water supply of neighboring cities is derived.

### SAN BERNARDINO COUNTY.

In 1911 San Bernardino County produced 6,161.38 fine ounces of gold, valued at $127,367, and 67,061 ounces of silver, valued at $35,542; 679,984 pounds of copper, valued at $84,998; 23,466 pounds of lead, valued at $1,056; and 182,316 pounds of zinc, valued at $10,392—a total of $259,355. This is $193,269 more than the total for 1910. In production of gold the county showed an increase of $72,274, and the silver also increased 48,239 ounces in quantity and $25,378 in value. The increase in copper was 673,992 pounds in quantity and $84,237 in value, and the increase in lead was 21,921 pounds and $988 in value. The zinc output is all increase, as there was no zinc produced in the county in 1910. There was a total of 55 mines in San Bernardino County in 1911, of which only one was a placer mine and this was a surface operation. Of the deep mines 26 were gold mines, 14 were copper mines, 5 silver mines, 8 silver-lead mines, and 1 zinc mine. There were 18,190 tons of ore produced in the county in 1911, of which 8,569 tons were siliceous ore, 9,201 tons copper ores, 155 tons lead ores, and 265 tons zinc ores. Of the ore output, 2,171 tons were sent to the gold and silver mills, from which no concentrates were produced, 10,698 tons were sent to the smelter, and 5,321 tons were treated as tailings.

The most productive property in San Bernardino County is that of the Pacific Mines Corporation at Ludlow. Including the vertical and incline shafts, about 5,000 feet of underground work has been done on the property. There are no reduction works. All the ore treated in 1911 was shipped to the smelter of the United Verde Copper Co. at Jerome, Ariz.

The Bagdad Chase mine at Barstow (now owned by the Pacific Mines Corporation) worked several thousand tons of tailings by the percolation method. The tankage capacity of the cyanide plant is about 1,000 tons. The mines at Barstow produced altogether $21,083 in value from gold, silver, copper, and lead. Most of the mines are small producers, as are those at Barnwell, Calzona, Cima, Danby, Fenner, and Leastalk. At Daggett considerable silver ore was mined, and the zinc output of the county came from near Nipton. There are no important producers at Silver Lake, Victorville, Vidal, or Von Trigger, though a number of mines producing gold, silver, copper, and lead are being worked. The California Gold and Copper Co., of Von Trigger, is erecting a mill. The electrolytic leaching plant, when completed, will have a capacity of 100 tons a day.

### SHASTA COUNTY.

*Mine production of Shasta County, Cal., 1910 and 1911.*

| Year. | Gold. | | Silver. | | Copper. | | Lead. | | Total. |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ozs.* | | *Fine ozs.* | | *Pounds.* | | *Pounds.* | | |
| 1910..... | 74,194.09 | $1,533,728 | 1,201,676 | $648,905 | 40,397,284 | $5,130,455 | 196 | $9 | $7,313,097 |
| 1911..... | 54,831.90 | 1,133,476 | 730,675 | 387,258 | 29,618,032 | 3,702,254 | ..... | ..... | 5,222,988 |
| Decrease (−) | −19,362.19 | −400,252 | −471,001 | −261,647 | −10,779,252 | −1,428,201 | −196 | −9 | −2,090,109 |

Shasta County is the most productive in metallic output in the State, its output for the year 1911 being valued at $5,222,988, or over $2,000,000 more than that of any other county. Nevertheless Shasta showed a decrease of $2,090,109 in total yield in 1911 as compared with 1910. This marked decrease is entirely due to the closing down of certain copper mines and smelters, owing to litigation over smelter fumes. The closing of smelters also resulted in stopping work at numerous gold and silver mines, which, having no reduction works, have heretofore sold their ores to the smelting establishments. The falling off in the yield in gold in Shasta County in 1911 was $400,252, in silver it was 471,505 ounces in quantity and $261,647 in value; and in copper 10,779,252 pounds in quantity and $1,428,201 in value. It is to be noted therefore that most of the decrease in total value in the county is due to the reduced yield in copper.

The total number of deep mines from which production was reported in 1911 was 53, of which 49 were gold mines, 3 were copper mines, and 1 was a silver mine. The tonnage of Shasta County in 1910 was the largest in the State, but in 1911 the tonnage of Amador County was greater. The output of 520,795 tons was made up of 421,866 tons of copper ores and 98,929 tons of siliceous ore.

From the deep mines of the county were obtained 50,714.56 fine ounces of gold, valued at $1,048,363, and from the placers approximately $12,000. The placer mines of the county include 1 dredge, 1 drift mine, and 8 surface mines. The deep mines yielded 730,030 ounces of silver, valued at $386,916.

The gold obtained from the siliceous ore amounted to 38,192.98 fine ounces, valued at $789,519, and that derived from copper ores was 12,521.58 fine ounces, valued at $258,844. The silver production from siliceous ore was 23,585 ounces, valued at $12,500, and that from copper ores 706,445 ounces, valued at $374,416. The siliceous ore, therefore, yielded $802,019 in gold and silver, and the copper ores yielded $633,260 in gold and silver, a total of $1,435,279 in gold and silver from the deep mines. Gold and silver mills in Shasta County in 1911 treated 63,420 tons of ore, which yielded in gold bullion $588,740, an average of $9.28 per ton, and 6,459 ounces of silver, valued at $3,423, an average of $0.06 per ton. The total recovery as mill bullion was valued at $592,163, an average value in gold and silver of $9.34 per ton. This ore produced 352 tons of concentrates, with a gold value of $33,788, and 579 ounces of silver, valued at $307, a total value in concentrates of $34,095. The average value per ton of the concentrates was $95.99 in gold and $0.87 in silver, a total average value of $96.86 per ton.

The gold value of the ore treated at the gold and silver mills was $622,528, an average of $9.81 per ton, and the silver value was $3,730, or $0.06 per ton, a gold and silver value from mill bullion and from concentrates of $626,258, or an average recovery of $9.87 per ton.

The crude ore sent to the smelters, amounting to 457,322 tons, produced (in addition to the copper) $425,455 in gold, an average of $0.93 per ton, and 722,132 ounces of silver, valued at $382,730, or $0.84 per ton. The total value of gold and silver recovered from the ore sent to the smelters was $808,185, or an average of $1.77 per ton.

There were treated in the county 53 tons of old tailings in 1911, which yielded $380 in gold and 860 ounces of silver, valued at $456, or a total value of $836.

The most marked feature in the mining conditions in Shasta County in 1911 was the final closing down of the Balaklala mines and smelter, although not until after considerable output had been made. The stoppage of work was due to injunctions over smelter-fume damages. The Bully Hill Co., formerly a large producer, did not operate its mines or smelter in 1911. The Mountain Copper Co. worked its mines and shipped its ores out of the county for treatment at its smelter, near Martinez, on San Francisco Bay. The original smelting plant of the company at Keswick has been idle some years. The operations of the Mammoth Copper Co., at Kennett, were curtailed to such an extent that the output of its smelter was over three-fourths of a million dollars less in value in 1911 than in 1910. Thus it is seen that of the 4 large smelting plants which have been in operation in Shasta County only 1 remained at work at the end of 1911, and operations even at that were on a smaller scale than usual.

The most productive mine in all metals in the county in 1911 was the Mammoth, but the largest gold producer was the Hazel Co. at French Gulch, which has for some years been working the Gladstone mine. This mine is opened by a tunnel 3,300 feet long and a 3-compartment shaft 900 feet deep, which was sunk 100 feet deeper in 1911. There is a 30-stamp mill with Wilfley concentrators and Frue vanners. The concentrating plant was doubled in size in 1911. Of other mines at French Gulch: The Accident supplied ore to a custom mill; the El Dorado and Eureka group has a 20-stamp mill and carries high-grade ore; the Empire and Evening Star are both small producers; the Brunswick has a 10-stamp mill, but it was only run for a few days in 1911, though considerable work was done in the mine itself. Some bullion was shipped from the Niagara Summit mine before it was closed down. The ore produced from the Summit Gulch mine was of high grade. The Tom Green mine made only a small output. The Washington is opened by tunnels from 500 to 2,000 feet in length and has connections from 4 levels; it has a 5-stamp water-power mill with Johnson concentrators. The mill, flumes, etc., were repaired in 1911, but all the work in the mine was done by lessees. The Western Exploitation Co. (Milkmaid group) has a 10-stamp mill with 4 concentrators; the mine is opened by an adit 800 feet long and a shaft 130 feet deep, with 1,500 feet of drifts. The total output of the combined deep mines in French Gulch district in 1911 was 42,517 tons of ore, yielding $420,451 in gold and 3,923 ounces of silver, valued at $2,080. The placers yielded $5,849 in gold. Ore from the Delta Consolidated at Bayles was not treated in its own mill in 1911, but was sold to the Mammoth Copper Co., as was ore from the Potosi or National, at Buckeye. The Atlantic and the Silver Falls, at Igo, are both small producers. The largest mining and smelting operations in the county are carried on at Kennett by the Mammoth Copper Mining Co. This company also operates the Original Quartz Hill mine at the same place, the output being used as a flux at the smelter. The Uncle Sam mine, also at Kennett, is developed by an adit 1,200 feet long, a shaft 500 feet deep, and 5,000 feet of drifts. A 10-stamp mill with concentrators was erected in 1911. The crushed ore is amalgamated on plates and in a Pierce amalgamator, and then passed on to Wilfley and Johnson concentrators. The Mountain Copper Co. operates 3 mines contiguous to one another at Iron Mountain, near Keswick; these are the

Iron Mountain, the No. 8, and the Hornet. The ore is shipped for reduction to the company's smelter near Martinez, on San Francisco Bay. The sulphide ore is roasted to manufacture sulphuric acid, and the resulting calcines, with suitable mixtures of other ores, are smelted in reverberatory furnaces. The copper matte carrying the gold and silver is converted to blister copper and shipped to the Baltimore Copper Smelting & Rolling Co., Baltimore, Md. Some copper cement is produced from the mine water by precipitation on scrap iron. The shaft on No. 8 mine was sunk from the 300-foot to the 450-foot level in 1911. The smelter was operated the entire year, some custom ore being handled as well as the company's ore. Also at Keswick is the mine of the Pittsburg & Mount Shasta Gold Mining Co., which is opened by a 700-foot shaft and has 2,500 feet of drifts. During 1911 a 15-stamp amalgamating mill, with concentrators, was built. The Midas mine at Knob (Harrison Gulch district) is one of the important gold producers of the county. The deepest of the shafts on the property is 1,000 feet. In 1911, 800 feet of crosscuts and 600 feet of drifts were run. The mill has 20 stamps and 6 Frue vanners. At this same place the Victor Power & Mining Co. lowered the 400-foot incline shaft on the Bonanza claim 200 feet during the year. A new 3-stamp Nissen mill with Johnson concentrators was tested during the year but not operated continuously. At Ono the Mariana Marsicano Co. is operating the Sunny Hill mine. The mines in the vicinity of Redding are all small producers, as are those near the old town of Shasta. At Whitehouse the Evening Star and Texas was only worked a few months, operations being discontinued on account of restricted smelting operations, which handicapped the mines in the sale of ores. The Reid mine at the same place is a reasonably large producer. The Big Backbone mine, at Kennett, was developed the whole year but made no output. It has now consolidated with the Elsie and Keystone properties, and the group is operated by the Kennett Consolidated Copper Cos. The Trinity Copper Co., at Kennett, was idle during 1911, as the company with which it had its ore contracts, the Balaklala, was closed, as has already been explained. The Consolidated Gold Dredging Co., of Redding, went out of business on account of the loss of its boat. The U. S. Gold Dredging Co. did not operate in 1911, its machine having been laid up for months. It never was worked practically for more than a few weeks. The only placer producer in Shasta County of much importance is the Shasta Dredging Co., operating on Clear Creek, near Horsetown (Larkin post office).

### SIERRA COUNTY.

The total production of Sierra County in 1911 was valued at $467,117, as compared with $313,365 in 1910, an increase for 1911 of $153,752. Of the total increase $149,478 was in gold output. The yield of the county in 1911 was 22,325.69 fine ounces of gold, valued at $461,513, and 10,574 ounces of silver, valued at $5,604. There were 35,360 tons of siliceous ore treated in Sierra County in 1911, yielding 12,467.93 fine ounces of gold, valued at $257,735, and 9,100 ounces of silver, valued at $4,823. The gold output from the placers was 9,857.76 fine ounces, valued at $203,778, and the silver was 1,474 ounces, valued at $781. Of this placer gold $50,016 was

taken from 6 hydraulic mines, $146,712 from 18 drift mines, and $7,050 from 12 sluicing or surface mines, there being 36 producing placers. Of the deep gold mines 26 were productive. The deep mines in 1911 produced $53,957 in gold more than the placers. The gold output of the deep mines increased in 1911 by $24,770, and the placer gold increased by $124,708. The deep mines in Alleghany district in 1911 produced 10,350 tons of ore, yielding $113,675 in gold, and 1,121 ounces of silver, valued at $594, a total of $114,269, which was a slight increase in value over the output of 1910. The principal mines making this output at Alleghany were the Croesus, Eastern Cross, Irelan, Independence, Twenty-One, Tightner, and Sixteen-to-One. The Croesus has 15,000 feet of horizontal tunnels and drifts and one inclined winze of 170 feet. The mill has 20 stamps with concentrators. Both the Eastern Cross and the Irelan are small producers. At the Independence mine the improvements were in 1911 a 1,200-foot pipe line, 7,900 feet of ditch, 140 feet of shaft, 120 feet of drifts, and a new 5-stamp mill. The Sixteen-to-One produced some "specimen" ore in 1911, and was equipped with new machinery. The Twenty-One is opened by a 2,000-foot adit, of which 600 feet was cut in 1911. Development work only was done, the ore taken out having been stored on the dump. A small quantity of selected ore was sold. The Tightner is opened by a 1,100-foot adit, and has a 10-stamp amalgamating mill with concentrators. The mine was worked the entire year, but the mill was only operated for two months. At Downieville the Mexican and the Sovereign are small producers, but the Sierra Standard is rather a large one, with high-grade ore. The ore treated is transported by mules to a custom mill at Downieville. Operations are carried on in a crude way. The mine is opened by a 450-foot tunnel and an 80-foot shaft. At Forest the Kate Hardy is worked through a 300-foot tunnel cut in 1911. There is no mill on the property. The Little Bear Creek mine, the nearest post office to which is Graniteville, Nevada County, has a small mill with concentrators, which was only run two months in 1911. Some shaft and tunnel work was done during the year. The Sierra Mining Co., operating the old Alaska mine at Pike, had the misfortune to lose its entire milling plant by fire in November, but immediately started in to put up a new mill of 40 stamps. The mine is opened by a shaft 700 feet deep. At Sierra City the Buttes Saddle Mining Co. has 3 tunnels, 1,000 feet, 300 feet, and 150 feet long, respectively, the latter having been driven in 1911. There is a 10-stamp mill with concentrators, which was started up in 1911 for the first time in several years on ore from a newly discovered ledge, but only had a short run, as water gave out. The Cleveland, at the same place, is a small producer. The Keystone is operated through a long tunnel, and is equipped with a 10-stamp mill. The Phoenix, at the same place, has a 20-stamp mill. At the Sacred Mount the 10-stamp mill was operated for four months. The Sierra Buttes, one of the most thoroughly developed mines in the State, has a 60-stamp mill with a 300-ton cyanide plant. The mine is opened by 9 tunnels from 500 to 16,000 feet in length, and in 1911 the operators did 1,150 feet of cross cutting, 600 feet of raising, and 1,500 feet of drifting.

Among the placer mines an important hydraulic property is operated near Brandy City, between Canyon Creek and North Yuba River, by the Brandy City Mining Co. Small producers at Downieville are the Soldier Boy, Telegraph drift, Best Chance, White Bear, Bunker Hill, and Orient. The Monte Cristo, 5 miles from Downieville, is the largest producer of all the drift mines of the State. The total placer output of all the mines at and near Downieville in 1911 was $132,986 in gold. At Forest are the Columbia Channel and the Omega drift mines, both productive. At Scales the Neocene Placer Mining Co. is hydraulicking. At Sierra City are the Ladies Canyon, Last Resort, Middle Yuba, and Pride mines. At St. Louis, Port Wine, and Table Rock, the placers are unimportant.

### SISKIYOU COUNTY.

In 1911 Siskiyou County produced 20,428.62 fine ounces of gold, valued at $422,297, and 4,832 ounces of silver, valued at $2,561, a total of $424,858, as compared with $439,698 in 1910. This was a decrease in value for 1911 of $14,840, all of which was for gold except $239. The 39 deep mines of the county yielded from 9,747 tons of ore 5,054.66 fine ounces of gold, valued at $104,489, and 2,130 ounces of silver, valued at $1,129, a total of $105,618, as compared with $125,990 in 1911. The 117 producing placers yielded 15,373.96 fine ounces of gold, valued at $317,808, and 2,702 ounces of silver, valued at $1,432, a total of $319,240, as compared with $313,708 in 1910. The placers thus yielded $213,622 more in value than the deep mines in 1911, and the placer output is apparently increasing, while that from the deep mines is steadily decreasing. There were 156 productive mines in Siskiyou County in 1911, which was 74 more than in any other county in the State, Butte, Placer, and Trinity counties being next in rank, with 82 mines each. Of the placers in Siskiyou County, the 77 hydraulic mines produced $217,579 in gold; the 2 dredges, $84,669; the 9 drift mines, $6,545; and the 29 sluicing or surface mines, $9,015. The number of hydraulic mines increased by 4 in 1911 and their output in gold increased $38,474. The dredge output in 1911 was $24,513 less in gold than in 1910, there having been 2 less dredges. The drift-mine output in gold increased by $4,927 in 1911, and the sluice-mine output in gold decreased by $13,324 in 1911. There are numerous placers in the county, as stated, but none of them are very large producers. There are no Federal restrictions on hydraulic mining in this county as there are in the drainage basins of San Joaquin and Sacramento Rivers, none of the streams being navigable or liable to damage from mining débris.

Among operators of deep mines the Mono Mining Co., at Yreka, was in 1911, as in 1910, the largest producer in the county. At Callahan the Adeline Ricks has a 10-stamp mill with concentrators, but it was only run a few days, and most of the work done on the mine was development. The old McKeen or Helena mine was not worked or leased in 1911 and is now controlled by the reincorporated Shasta Mining Co. The Highland, at Etna Mills, has a small mill in which high-grade ore is treated. The Keating was equipped with a 2-stamp Hendy mill driven by a gas engine. The Taylor Lake or Zarina has a 10-stamp mill with concentrators, but it was run only

a short time in 1911. At Fort Jones the Cameron has a 5-stamp mill, but only a small output was made. At Gilta the Knownothing, which is equipped with an 8-stamp mill, is worked by its owners, who do all the labor. The Pilot Knob, at Gottville, has a 5-stamp mill, but the mine was worked only three months in 1911. At Greenview operators of the Oom Paul and the Johnstone lease a mill to work the ores. The mines at Hawkinsville are mainly pocket mines, the ore being worked in arrastres, or else by hand mortar and gold pan. At one of them, the Easter, the arrastre is run by a 24-foot water wheel. The mines at Hilts are of the same character as those at Hawkinsville. Ore of the China Gulch or Hicks mine, at Hornbrook, is treated in an arrastre. Operators of the Ida May and the Elizabeth Sanger mines, at Rollin, have a 2-stamp mill, and have been milling waste dumps while development work was going on. The Columbia and the Mabel, at Scott Bar, are worked through a 500-foot adit. The 5-stamp mill was operated only 7 weeks during the year. A compressor, belt driven from a gasoline engine, was added in 1911. At the Jeffries pocket mine at the same place a hydraulic plant was put in to pipe off the surface and expose the vein. A tunnel has also been run in on the lode. At Snowden the Lanky Bob and the Overton are small producers. Near Yreka the only deep mine of much importance is that of the Mono Mining Co.

Of the placers the largest producers are the Northern California, at Croy; Michigan Salmon, at Black Bear; Bennett & Co., at Forks of Salmon; Siskiyou Dredging Co., at Fort Jones; Lucky Bob, at Gottville; Weed & Gardner, at Greenview; Dick Morris, at Hamburg; Nolan Bar and Van Brunt, at Happy Camp; Frisbie, at Hilt; Kelly Bar, at Hornbrook; Wright & Fletcher, at Oro Fino; Forks of Salmon, Gold Hill, Russian & Dump, Burns, and Gallia, at Sawyers Bar; and Montezuma, at Scotts Bar.

Of the principal placer districts in Siskiyou County in 1911 the Fort Jones district produced $99,069 in gold; Sawyers Bar, $54,525; Forks of Salmon, $22,280; Callahan, $5,433; Scotts Bar, $6,572; Happy Camp, $12,658; Black Bear, $10,257; and Walker, $4,525. Placer mines were also worked at Cecilville, Doris, Gottville, Greenview, Hamburg, Hawkinsville, Hilts, Hornbrook, Hutton, Oak Bar, Oro Fino, Seiad, Somesbar, and Yreka.

In explanation of the fact that there were four dredges in operation in Siskiyou County in 1910 and only two in 1911, it may be stated that the Scott River Dredging Co., at Callahan, ceased operations and went out of business in May, 1910; and further that the Northern California Mining Co., working the McConnell Bar mine at Croy and classed as a dredge in the 1910 report, is in the 1911 report classed as a hydraulic mine, for the reason that the process now employed in working the gravel is hydraulic mining supplied by a clam-shell dredge.

### TRINITY COUNTY.

In 1911 Trinity County produced 29,612.71 fine ounces of gold, valued at $612,149, and 12,786 ounces of silver, valued at $6,777, a total value of $618,926, which was $116,115 more than the total in 1910. There were 82 producing mines in the county in 1911, of which 24 were deep and 58 were placer mines. The deep mines pro-

duced 67,925 tons of ore, which yielded 14,410.91 fine ounces of gold, valued at $297,900, and 10,262 ounces of silver, valued at $5,439, a total of $303,339, as compared with a total of $127,628 in 1910. The 57 placers yielded 15,201.80 ounces of gold, valued at $314,249, and 2,524 ounces of silver, valued at $1,338, a total of $315,587. This amount is not the exact value of the placer gold produced, as the output of the one dredge in the county was added to those of Merced, Shasta, and Stanislaus, in order to conceal individual output. The transfer of the gold output of the dredge in Trinity County does not materially affect the tables as the placer production of Trinity County is large. The 46 hydraulic mines produced $308,676 in gold, and the 11 sluicing mines produced $5,573 in gold, there being no producing drift mines in the county in 1911. In hydraulic mining Trinity stands first among the counties of the State, the largest hydraulic mine in the United States, the La Grange, being in this county. In Trinity County, as in Siskiyou County, there are no restrictions requiring the impounding of the mining débris, as these counties are outside the drainage basins of the Sacramento and San Joaquin rivers, where the Government restriction applies to this character of gravel mining in navigable streams.

The principal deep mine in the county is owned by the Trinity Gold Mining & Reduction Co. (Headlight mine) at Carrville. At this property the ore body lies almost flat, and the overburden is removed by water under pressure (hydraulic system), and the ore is mined by open cut. The mill is of 40 stamps and the cyanide plant of 200 tons capacity. The process is "straight cyanide"—that is, by leaching the sands and agitating the slimes. At Coffee, the Coffee Creek Mining Co. (Golden Jubilee mine) has two tunnels of a total length of 670 feet, and 460 feet of drifts. The company has a Huntington mill (completed in December, 1911) and a cyanide plant. At Deadwood the principal mine is the Brown Bear, an old and productive mine, opened by tunnels. The 10-stamp mill, with concentrators, was only run 80 days in 1911, but work was continuous in the mine. At Dedrick, the Globe Mining Co. (formerly the Trinity County Mining Co.) has an old-fashioned 10-stamp mill. At the Sherwood, at Denny, the 10-stamp mill and concentrators were operated only two months in 1911, but the mine was worked during the entire year. In the Dorleska mine, at Dorleska, very little work was done in 1911 and that by lessees. The Gold Bug, Klondike, and May group at the same place has a 5-stamp water-power mill; and the Yellow Rose has a Huntington mill. The Bullychoop, at Douglas City, was only operated a few weeks during the year. The Salmon Summit has a small mill, and the mine was only worked a short time. The Coleridge, at Helena, has a 10-stamp mill with concentrators. The Fairview, at Minersville, was operated under lease. The Trinity Bonanza King Mining Co., at Trinity Center, has a 20-stamp amalgamation mill, and operated only about two months; the company has been declared bankrupt.

As to the placers of Trinity County, the most productive is the La Grange hydraulic mine, near Weaverville, the largest hydraulic property in the United States. Other placers of importance are the Fidor d'Italia, at Carrville; Indian Creek, Steiners Flat, and Union Hill, at Douglas City; King & Bayles, at Helena; Chapman & Fisher and Maple Creek, at Junction City; Jim Sing, at Lewiston; Sykes, at

Trinity Center; and Homestake-Ellerbrook and Hupp, at Weaverville. The mining district embracing the mines around Douglas City produced $46,347 in gold and silver in 1911; $20,140 at Junction City; and $200,383 at Weaverville. The silver output in each case was unimportant. Other placers were worked productively in a smaller way at Big Bar, Burnt Ranch, Coffee, Dedrick, Denny, Hayfork, and Minersville. The only dredge in the county is at Minersville.

## TUOLUMNE COUNTY.

*Mine production of Tuolumne County, Cal., in 1910 and 1911.*

| Year. | Gold. | | Silver. | | Total. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ozs.* | | *Fine ozs.* | | |
| 1910 | 29,780.90 | $615,626 | 10,655 | $5,754 | $621,380 |
| 1911 | 52,897.29 | 1,093,484 | 24,987 | 13,243 | 1,106,727 |
| Increase (+) | +23,116.39 | +477,858 | +14,332 | +7,489 | +485,347 |

The gold output of Tuolumne County increased in 1911 by $477,858, and the silver increased 14,332 ounces in quantity and $7,849 in value, a total increase in value of output of the county of $485,347 in 1911. In 1911 the county mines produced 52,897.29 fine ounces of gold, valued at $1,093,484, and 24,897 fine ounces of silver, valued at $13,243, a total of $1,106,727 in gold and silver. There were 55 deep producing mines in the county, 18 more than in 1910, and 8 placers, a total of 63 mines. Six of the placers were drift mines and 2 were sluicing mines. The combined production of these placers in 1911 was $6,634 in gold and 57 ounces of silver, valued at $30. With the exception of two at Chinese, the placer producers were at Columbia. The largest producer of placer gold in the county was the Springfield Tunnel Co.

The ore sold or treated in the county in 1911 amounted to 308,652 tons, of which 149 tons were old tailings. The 308,503 tons treated at the gold and silver mills yielded in bullion $637,106 in gold, an average of $2.07 per ton, and 17,911 ounces of silver, valued at $9,493, an average of $0.03 per ton, a total saved in mill bullion valued at $646,599, or an average of $2.10 per ton in gold and silver.

From this milling ore 10,867 tons of concentrates were obtained, which yielded $448,556 in gold, an average of $41.28 per ton, and 7,004 ounces of silver, valued at $3,712, an average of $0.34 per ton, a total of $452,268 in gold and silver, and a total average yield of $41.62 per ton in gold and silver.

The ore milled and concentrated yielded a total of $1,085,662 in gold, an average of $3.52 per ton, and 24,915 ounces of silver, valued at $13,205, or $0.04 per ton. The total yield of gold and silver on the plates and from concentrates was valued at $1,098,867, an average yield of $3.56 per ton.

The 149 tons of tailings yielded $1,188 in gold and 15 ounces of silver, valued at $8, a total yield of $1,196.

The most productive mine in the county in 1911 was the Eagle Shawmut, at Shawmut, which is developed by an inclined shaft

1,800 feet deep and winze 600 feet, a total depth of 2,400 feet. The mine has a 100-stamp mill, with concentrators, and an exceptionally fine chlorination plant. Operations had to be suspended for two months of the year, owing to shortage of water supply. Next in order of production was the well-known App mine, at Quartz, owned by the Nevill Investment Co. Following this in rank is the Harvard, of Jamestown, which is opened by inclined and vertical shafts, 750 feet and 1,200 feet deep, respectively. The mine has a 60-stamp mill which, with the mine, was operated the entire year. The Dutch Consolidated Mining Co. in 1911 reopened the old Dutch mine, retimbered the shaft, and almost completed the 20-stamp mill, to which 20 stamps were added in 1912. The mine is opened by two inclined shafts, one 1,700 feet deep and the other 200 feet deep with about 13,000 feet of drifts. A great deal of development work was done during the year. Next in importance to the Dutch in point of total production is the old Black Oak, at Soulsbyville, reopened a few years since after long idleness, and not since then until 1911 productive to any extent. At this property they have a modern 20-stamp mill, and crush and cyanide all ore direct without amalgamation or concentration. The deep mines at Big Oak Flat and Chinese are unimportant, although at the latter place the United Gold Mining Co. (Tarantula and Omega mines) erected in 1910 and 1911 a 20-stamp mill, but after operating it a few days suspended in order to permit of more comprehensive mine development. The operators cut 430 feet of winzes and 820 feet of drifts and crosscuts. On the Rio Tagus (old Contention mine), at Columbia, a 10-stamp mill with Gates concentrating tables and vanner as well as a compressor plant was put in during 1911 by parties operating under bond, but they ceased operations in September, after having made only a small output. The Cosmopolite, at Groveland, has a 5-stamp mill as has the O'Donnell, at Jamestown. The Crystalline mine at this latter place has a vertical shaft 600 feet deep, and 6,000 feet of drifts and crosscuts. The mine was only operated for two months. The mill has 10 stamps and concentrators. Most of the mines near Sonora are pocket mines, having no mills. At the old Soulsby mine, Soulsbyville, where there is a 20-stamp mill with concentrators, a considerable production was made until August, 1911, when operations were temporarily stopped. At the Jumper Californian gold mines, at Stent, where there is an incline shaft 1,450 feet deep, no new work was done in 1911. Whatever work has been done has been on the New Era claim. There have been frequent reorganizations, but now the Jumper, the New Era, and the Golden Rule claims are owned and being operated as one property by a single company, a French syndicate, with head office at Paris, France. The old Dreisam mine, at Tuolumne City, has a 400-foot vertical shaft, and was only operated three months in 1911. The mill consists of two 3-stamp batteries. The Mohican, at Tuolumne City, was operated only two months, the remainder of the year being devoted to prospecting. The mill has 5 stamps. The New Providence at Tuolumne City (to be hereafter known as the Enterprise), has a 1,200-foot shaft which has been cleaned out and repaired, and some little stoping has been done. The mill has 10 stamps. The Starr King and the Sherman mines at Tuolumne City have a shaft 500 feet deep with 4 laterals averaging 150 feet north and south. The

mill has 5 stamps but no concentrators. The United Mines at Tuolumne City, has an incline shaft 700 feet deep with winzes, making a total depth of 950 feet. The mill has 20 stamps, and a 75-ton capacity cyanide plant was installed in 1911. The Chileno, at Tuttletown, has a 3-stamp mill, and the Criss Cross at the same place has one of 6 stamps. The deep mines at Jamestown in 1911 produced $235,477 in gold from 105,123 tons of ore; those at Sonora produced $19,145 from 372 tons of ore, and those at Tuolumne City produced $50,899 in gold.

### YUBA COUNTY.

In 1911 Yuba County produced more gold than any other county in California—as was the case in 1910—the total being $2,997,072, all with the exception of $8,173 from placer operations, mainly dredges. The decrease in gold production in the county in 1911 was $207,201 there having been two less dredges at work than in 1910.

Yuba County produced 144,983.36 fine ounces of gold in 1911, valued at $2,997,072, and 9,998 ounces of silver, valued at $5,299. The deep mines of the county at Brownsville and Dobbins produced 398 tons of ore, yielding 395.37 fine ounces of gold, valued at $8,173, and 289 ounces of silver, valued at $153, a total of $8,326.

Of the 33 placer operations 13 are dredges and 20 are sluicing properties. None of these placers are important producers except the dredges, only $24,162 of the placer gold having come from the sluicing mines. One of the large dredges of the Yuba Consolidated Goldfields was destroyed by fire in November, and one of the Marysville Gold Dredging Co. was dismantled during 1911, being too light for the deep ground. It was replaced in April by a new 8½-foot bucket boat. The big Yuba No. 13 of the Yuba Consolidated Goldfields is equipped with 15 cubic foot buckets, and is the largest in the world, digging to 65 feet below water level. It has dug at times over 65,000 cubic yards in a week. In addition to the loss by fire of the dredge of the Yuba Consolidated Goldfields, work on the old Bear River dredge of the Oroville Dredging Co., which was operating in Yuba County, was closed down in September, 1910. This accounts for the two dredges less in 1911 than in 1910.

## COLORADO.

By Charles W. Henderson.

### PRODUCTION.

The total value of the production of gold, silver, copper, lead, and zinc in Colorado in 1911, as reported from 861 productive mines, 39 of which were placers, amounted to $32,418,218, as compared with $33,673,879 in 1910, a decrease for 1911 of $1,255,661. Of the total value, 58.6 per cent represented gold, which was valued at $19,001,975, a decrease of $1,505,083, as compared with the yield of 1910. There was a decrease in silver output of 1,179,430 fine ounces. The production of copper, which is mainly incidental to the recovery of other metals, decreased somewhat. The tonnage of true copper ores increased slightly. The quantity of copper in the dry ores of Gilpin, Ouray, and San Miguel counties increased, while that in the dry ores

of Lake and San Juan counties decreased—the combined production showing a slight net decrease. The quantity of lead produced in 1911 was 69,679,289 pounds, a decrease of 6,391,984 pounds, though the tonnage of true lead ores increased slightly. The quantity of zinc produced was 94,607,456 pounds, an increase of 17,517,808 pounds.

The output of ore sold or treated in 1911 from Colorado mines was 2,377,936 short tons, a decrease of 56,728 tons, as compared with the output of 1910.

The output of siliceous or dry ores was 1,874,103 tons, a decrease of 83,276 tons. The average value of siliceous or dry ores per ton in gold and silver was $11 in 1911, as compared with $11.65 in 1910, with $13.41 in 1909, with $13.10 in 1908, with $14.49 in 1907, and with $14.90 in 1906.

The output of copper ores was 18,221 tons, an increase of 3,143 tons. The production of lead ores was 158,984 tons, an increase of 25,661 tons, and the output of zinc ores increased from 82,251 tons in 1910 to 110,845 tons, an increase of 28,594 tons. There were only 1,398 tons of copper-lead ores produced in 1911, a decrease of 821 tons. The output of lead-zinc ores was 214,385 tons, a decrease of 30,029 tons. The combined output of zinc and lead-zinc ores showed a decrease of 1,435 tons.

The average value per ton of copper ores in gold and silver was $19.58; of lead ores, $6.53; of zinc ores, $0.30; of copper-lead ores, $47.28; and of lead-zinc ores, $2.16. The average value per ton in gold and silver of all the ore mined in Colorado in 1911 was $9.49, as compared with $10.15 in 1910, with $11.78 in 1909, with $14.16 in 1908, with $15.67 in 1907, with $16.47 in 1906, with $17.37 in 1905, and with $17.89 in 1904.

During 1911 there were treated at amalgamating, cyaniding, or chlorinating mills, with or without concentration equipment (including all the custom mills in the State), 1,373,879 tons of ore, with an average recovery as bullion or precipitates of $9.01 per ton in gold and of $0.15 in silver.

From the 1,373,879 tons treated at amalgamating, cyaniding, and chlorinating mills, and from 465,283 tons sent to concentration and separation mills, a total to both classes of mills of 1,839,162 tons (77 per cent of the total tonnage treated, as compared with 79 per cent in 1910), were produced 201,010 tons of concentrates—ratio 9 to 1—averaging $11.29 for gold, $5.19 for silver, $1.63 for copper, $10.04 for lead, and $11.70 for zinc, with a total average value per ton of $39.85, as compared with $38.68 in 1910.

Ore milled in 1911, in terms of metals recovered as bullion or by concentration, averaged $7.96 for gold, $0.68 for silver, $0.18 for copper, $1.10 for lead, and $1.28 for zinc, with a total value per ton of $11.20, as compared with $8.80 in 1910.

Crude ore shipped to all kinds of smelters amounted to 538,774 tons, averaging $7.25 for gold, $4.88 for silver, $1.26 for copper, $2.07 for lead, and $5.64 for zinc, with a total value per ton of $21.10, as compared with $20.68 in 1910.

Crude ore and concentrates shipped to all kinds of smelters therefore amounted to 739,784 tons, averaging $8.35 for gold, $4.96 for silver, $1.35 for copper, $4.24 for lead, and $7.29 for zinc, a total of $26.19 per ton.

In 1911 there were 39 productive placers in Colorado, which yielded $319,759 in gold and 3,669 ounces, valued at $1,945, in silver, a total of $321,704 in gold and silver, as compared with $398,140 in 1910, with $461,508 in 1909, and with $186,058 in 1908.

The statement of Colorado production for 1910 and 1911, showing increase or decrease, and value at each year's commercial price, is as follows:

*Mine production of gold, silver, copper, lead, and zinc in Colorado, in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 992,028.93 | $20,507,058 | 919,220.54 | $19,001,975 | − 72,808.39 | −$1,505,083 |
| Silver.....do.... | 8,509,598 | 4,595,183 | 7,330,168 | 3,884,989 | − 1,179,430 | − 710,194 |
| Copper.....pounds.. | 8,359,535 | 1,061,661 | 8,024,488 | 1,003,061 | − 335,047 | − 58,600 |
| Lead.....do.... | 76,071,273 | 3,347,136 | 69,679,289 | 3,135,568 | − 6,391,984 | − 211,568 |
| Zinc.....do.... | 77,089,648 | 4,162,841 | 94,607,456 | 5,392,625 | +17,517,808 | + 1,229,784 |
| Total..... | ..... | 33,673,879 | ..... | 32,418,218 | ..... | − 1,255,661 |

## GOLD.

The total gold production for Colorado in 1911 was 919,220.54 fine ounces, valued at $19,001,975, as against 992,028.39 fine ounces, valued at $20,507,058 in 1910, a decrease of 72,808.93 fine ounces in quantity and of $1,505,083 in value.

The Cripple Creek district, with a decrease of $439,600, produced $10,562,653 in gold, which was 56 per cent of the Colorado gold output from all sources, and 57 per cent of the gold from deep mines. Ouray County's gold production showed a decrease of $242,889.

In addition to those from Teller and Ouray counties, notable decreases were recorded from San Juan, Park, and La Plata, with less marked decreases from Gunnison, Summit, Lake, Chaffee, Clear Creek, Custer, Dolores, San Miguel, and Pitkin counties. Mineral County made an appreciable increase, with lesser increases from Gilpin, Boulder, Costilla, and Eagle counties.

Siliceous and dry ores, which made 79 per cent of all the tonnage mined, yielded 866,252.76 fine ounces, valued at $17,907,034, or 94 per cent of all the gold production. A little less than 2 per cent came from lead ores, a little less than 1 per cent from copper ores, a little less than 1 per cent from copper-lead ores, and 1 per cent from zinc and lead-zinc ores. Nearly 2 per cent came from placers.

The output of placer gold in 1911 was 15,468.34 fine ounces, valued at $319,759, a decrease of $75,706. Summit County, with 3 dredges and 9 placers, produced nearly 81 per cent of the placer yield. The greater part of the remainder came from sluicing operations in Park County and from a dredge in Costilla County. There were small placer yields in Chaffee, Clear Creek, Douglas, Eagle, Gilpin, Gunnison, Mesa, Moffat, Routt, and San Juan counties.

*Source of gold product in Colorado in 1911, by kinds of ore, by counties, in fine ounces.*

| County. | Placers. | Deep mines. | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|
| | | Dry and siliceous gold and silver ores. | Copper ores. | Lead ores. | Zinc ores. | Copper-lead ores. | Lead-zinc ores. | |
| Boulder | | 7,551.88 | 9.64 | 332.02 | | | | 7,893.54 |
| Chaffee | 285.08 | 71.21 | 5.62 | 2,817.01 | | | | 3,178.92 |
| Clear Creek | 84.85 | 19,705.19 | 2,320.27 | 1,968.83 | 27.01 | 155.56 | 854.93 | 25,116.64 |
| Costilla | 1,056.12 | | | | | | | 1,056.12 |
| Custer | | 267.70 | .03 | 1.23 | | | | 268.96 |
| Dolores | | 343.01 | .12 | 19.08 | | .47 | 3.28 | 365.96 |
| Douglas | 8.03 | | | | | | | 8.03 |
| Eagle | 1.74 | 1,887.91 | 6.68 | 6.82 | | | 87.97 | 1,991.12 |
| Fremont | | | | | .49 | 8.12 | | 8.61 |
| Gilpin | 22.06 | 34,773.13 | 2,705.04 | 165.08 | | 7.88 | | 37,673.19 |
| Gunnison | 68.55 | 6,601.32 | .26 | 334.07 | | | 12.06 | 7,016.26 |
| Hinsdale | | 147.15 | 8.71 | .10 | | 5.09 | 24.22 | 185.27 |
| Lake | | 43,109.56 | 3,401.58 | 6,968.80 | 135.17 | 100.28 | 1,114.87 | 54,830.26 |
| La Plata | | 13,880.58 | | | | | | 13,880.58 |
| Mesa | 1.35 | | | | | | | 1.35 |
| Mineral | | 1,035.06 | | 24.06 | | | 7,609.49 | 8,668.61 |
| Montezuma | | .77 | | | | | | .77 |
| Moffat | 239.07 | | | | | | | 239.07 |
| Ouray | | 92,846.99 | 6.10 | 1,099.50 | | 521.75 | | 94,474.34 |
| Park | 1,180.88 | 686.90 | | 978.18 | | .04 | | 2,846.00 |
| Pitkin | | 15.71 | | | | | 10.51 | 26.22 |
| Routt | 56.74 | | | | | | | 56.74 |
| Saguache | | 5.48 | 2.54 | 1.87 | | 14.88 | | 24.77 |
| San Juan | 11.08 | 13,259.49 | 3.75 | 2,722.85 | 1.87 | 67.98 | 209.38 | 16,276.40 |
| San Miguel | | 118,318.76 | 1.74 | 93.81 | | | | 118,414.31 |
| Summit | 12,452.79 | 776.62 | | 232.11 | | | 288.64 | 13,750.16 |
| Teller | | 510,968.34 | | | | | | 510,968.34 |
| Total | 15,468.34 | 866,252.76 | 8,472.08 | 17,765.42 | 164.54 | 882.05 | 10,215.35 | 919,220.54 |

## SILVER.

The silver yield in 1911 was 7,330,168 fine ounces, valued at $3,884,989, as against 8,509,598 fine ounces, valued at $4,595,183 in 1910, a decrease of 1,179,430 fine ounces in quantity and of $710,194 in value.

Lake County showed for 1911 a decrease of 314,719 ounces, but the output was 41 per cent of the State yield, as compared with 39 per cent in 1910 and with 38 per cent in 1909. Other decreases of note were in La Plata, Mineral, San Juan, and San Miguel counties. Notable increases in output of silver were shown in Eagle, Gilpin, Ouray, and Summit Counties.

In the production of silver 8 counties, ranking in the order named, Lake, San Miguel, Mineral, Ouray, Pitkin, Clear Creek, San Juan, and Gilpin, furnished 90 per cent of the total.

Siliceous or dry ores yielded 5,096,026 fine ounces, or nearly 70 per cent of the silver output; lead ores, 1,265,594 ounces, or 17 per cent; lead-zinc ores, 476,049 ounces, or 6 per cent; copper ores, 342,550 ounces, or nearly 5 per cent; copper-lead ores, 90,311 ounces, or 1 per cent; zinc ores, 55,969 ounces, or less than 1 per cent. A negligible per cent came from placers.

*Source of silver product in Colorado in 1911, by kinds of ore, by counties, in fine ounces.*

| County. | Placers. | Deep mines. | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|
| | | Dry and siliceous gold and silver ores. | Copper ores. | Lead ores. | Zinc ores. | Copper-lead ores. | Lead-zinc ores. | |
| Boulder | ..... | 44,962 | 240 | 8,551 | ..... | ..... | ..... | 53,753 |
| Chaffee | 47 | 2,399 | 397 | 88,498 | ..... | 757 | ..... | 92,098 |
| Clear Creek | 26 | 152,902 | 38,556 | 114,150 | 46,274 | 1,397 | 84,536 | 437,841 |
| Costilla | 96 | ..... | ..... | ..... | ..... | ..... | ..... | 96 |
| Custer | ..... | 12,776 | 133 | 270 | ..... | ..... | ..... | 13,179 |
| Dolores | ..... | 25,461 | 2,704 | 15,813 | ..... | 292 | 11,932 | 56,202 |
| Eagle | ..... | 60,110 | 115 | 48,028 | ..... | ..... | 7,856 | 116,109 |
| Fremont | ..... | ..... | ..... | ..... | 137 | 1,208 | ..... | 1,345 |
| Gilpin | 4 | 271,129 | 15,953 | 5,166 | ..... | 407 | ..... | 292,659 |
| Gunnison | 26 | 13,158 | 58 | 5,499 | ..... | ..... | 13,800 | 32,541 |
| Hinsdale | ..... | 1,983 | 1,699 | 289 | ..... | 2,572 | 1,210 | 7,753 |
| Lake | ..... | 2,199,024 | 278,184 | 338,007 | 8,299 | 7,355 | 176,427 | 3,007,296 |
| La Plata | ..... | 68,167 | 1,271 | ..... | ..... | ..... | ..... | 69,438 |
| Mineral | ..... | 481,994 | ..... | 6,060 | ..... | ..... | 57,265 | 545,319 |
| Montezuma | ..... | 1 | 5 | ..... | ..... | ..... | ..... | 6 |
| Moffat | 21 | ..... | ..... | ..... | ..... | ..... | ..... | 21 |
| Ouray | ..... | 398,283 | 1,251 | 105,531 | ..... | 7,735 | ..... | 512,800 |
| Park | 49 | 13,264 | 6 | 55,555 | ..... | 198 | ..... | 69,072 |
| Pitkin | ..... | 149,681 | ..... | 291,636 | ..... | ..... | 9,455 | 450,772 |
| Routt | 26 | ..... | ..... | ..... | ..... | ..... | ..... | 26 |
| Saguache | ..... | 987 | 615 | 2,009 | 668 | 385 | ..... | 4,664 |
| San Juan | 6 | 182,477 | 1,100 | 63,722 | 591 | 68,005 | 9,703 | 325,604 |
| San Miguel | ..... | 906,240 | 263 | 94,331 | ..... | ..... | ..... | 1,000, 34 |
| Summit | 3,368 | 53,245 | ..... | 22,479 | ..... | ..... | 103,865 | 182,957 |
| Teller | ..... | 57,783 | ..... | ..... | ..... | ..... | ..... | 57,783 |
| Total | 3,669 | 5,096,026 | 342,550 | 1,265,594 | 55,969 | 90,311 | 476,049 | 7,330,168 |

## COPPER.

The copper output in 1911 decreased in quantity from 8,359,535 pounds to 8,024,488 pounds and in value from $1,061,661 to $1,003,061. Copper production was reported from 21 counties in 1911.

As usual, Lake County was the leading copper producer, yielding 50 per cent of the State output in 1911; San Miguel was second, with 12 per cent of the total; Gilpin, Clear Creek, Ouray, and San Juan counties followed in order. These 6 counties produced 95 per cent of the total.

Siliceous or dry ores yielded 5,614,076 pounds, or 70 per cent of the copper output; copper ores, 1,652,247 pounds, or nearly 21 per cent; lead ores, 492,422 pounds, or 6 per cent; lead-zinc ores, 160,835 pounds, or 2 per cent; copper-lead ores, 93,025 pounds, or 1 per cent; zinc ores, 11,883 pounds, or less than 1 per cent.

*Source of copper product in Colorado in 1911, by kinds of ore, by counties, in pounds.*

| County. | Dry and siliceous gold and silver ores. | Copper ores. | Lead ores. | Zinc ores. | Copper-lead ores. | Lead-zinc ores. | Total. |
|---|---|---|---|---|---|---|---|
| Boulder | 21,998 | 2,269 | 3,485 | | | | 27,752 |
| Chaffee | 419 | 22,743 | 60,676 | | 4,610 | | 88,448 |
| Clear Creek | 319,767 | 203,633 | 88,757 | | 7,293 | 30,918 | 650,368 |
| Custer | 1,356 | 284 | | | | | 1,640 |
| Dolores | | 307 | 1,204 | | 1,478 | 299 | 3,288 |
| Eagle | 64,886 | 605 | 1,117 | | | | 66,608 |
| Fremont | | | | 3,596 | 10,380 | | 13,976 |
| Gilpin | 733,479 | 214,946 | 856 | | 959 | | 950,240 |
| Gunnison | 5,463 | 373 | 528 | | | 3,564 | 9,928 |
| Hinsdale | 1,078 | 10,069 | 79 | | 1,834 | 8,636 | 21,696 |
| Lake | 2,671,794 | 1,110,090 | 126,622 | 3,763 | 17,683 | 87,552 | 4,017,504 |
| La Plata | 595 | 73,133 | | | | | 73,728 |
| Mineral | 13,735 | | | | | 19,649 | 33,384 |
| Montezuma | | 183 | | | | | 183 |
| Ouray | 525,757 | 6,577 | 24,537 | | 7,402 | | 564,273 |
| Park | 3,539 | 3,039 | 17,271 | | 367 | | 24,216 |
| Pitkin | | | | | | 7,408 | 7,408 |
| Saguache | 436 | 980 | 271 | 850 | 2,447 | | 4,984 |
| San Juan | 273,774 | 2,726 | 149,357 | 3,674 | 38,572 | 2,809 | 470,912 |
| San Miguel | 955,588 | 290 | 15,186 | | | | 971,064 |
| Summit | 20,412 | | 2,476 | | | | 22,888 |
| Total | 5,614,076 | 1,652,247 | 492,422 | 11,883 | 93,025 | 160,835 | 8,024,488 |

## LEAD.

The lead production in Colorado in 1911 was 69,679,289 pounds, valued at $3,135,568, as against 76,071,273 pounds, valued at $3,347,136 in 1910, a decrease of 6,391,984 pounds in quantity and of $211,568 in value.

There were marked decreases in output from San Juan, Pitkin, San Miguel, Park, Lake, Mineral, and Hinsdale counties. Increases of note were made in Clear Creek, Dolores, Eagle, Gilpin, and Summit counties.

In rank, Lake County led, with 18,499,089 pounds; Pitkin was second, with 11,084,334 pounds; Mineral was third, with 7,674,556 pounds; San Juan was fourth, with 6,933,822 pounds; San Miguel was fifth, with 6,456,333 pounds; Summit was sixth, with 6,024,867 pounds; and Ouray, Clear Creek, Gilpin, and Chaffee followed in order. There was an increase of 25,661 tons in the tonnage of lead ores produced, but a decrease of 30,029 tons in that of lead-zinc ores. Siliceous or dry ores yielded 18,724,095 pounds, or nearly 27 per cent of the lead output; lead ores, 26,466,369 pounds, or 38 per cent; lead-zinc ores, 23,687,597 pounds, or 34 per cent; zinc ores 407,007 pounds, or nearly 1 per cent; copper and copper-lead ores combined a little less than 1 per cent.

*Source of lead product in Colorado in 1911, by kinds of ore, by counties, in pounds.*

| County. | Dry and siliceous gold and silver ores. | Copper ores. | Lead ores. | Zinc ores. | Copper-lead ores. | Lead-zinc ores. | Total. |
|---|---|---|---|---|---|---|---|
| Boulder | 54,072 | | 91,883 | | | | 145,955 |
| Chaffee | 8,537 | | 957,219 | | 35,895 | | 1,001,651 |
| Clear Creek | 516,598 | | 1,565,058 | 339,854 | 43,668 | 860,044 | 3,325,222 |
| Custer | 4,940 | | 12,571 | | | | 17,511 |
| Dolores | 1,785 | | 343,706 | | 4,268 | 351,485 | 701,244 |
| Eagle | 172,092 | | 141,964 | | | 541,833 | 855,889 |
| Fremont | | | | | 19,904 | | 19,904 |
| Gilpin | 1,166,318 | | 71,200 | | 1,838 | | 1,239,356 |
| Gunnison | 202,219 | | 148,557 | | | 281,157 | 631,933 |
| Hinsdale | 3,322 | | 343 | | 6,179 | 108,801 | 118,645 |
| Lake | 3,014,019 | 64,762 | 6,887,194 | 36,058 | 27,875 | 8,469,181 | 18,499,089 |
| La Plata | 1,511 | | | | | | 1,511 |
| Mineral | 1,104,981 | | 32,082 | | | 6,537,493 | 7,674,556 |
| Ouray | 2,982,838 | 2,218 | 953,129 | | 11,637 | | 3,949,822 |
| Park | 29,081 | | 893,415 | | 593 | | 923,089 |
| Pitkin | 156,885 | | 10,647,635 | | | 279,814 | 11,084,334 |
| Saguache | 526 | | 25,629 | 24,854 | 23,547 | | 74,556 |
| San Juan | 3,300,559 | 720 | 2,495,379 | 6,241 | 151,117 | 979,806 | 6,933,822 |
| San Miguel | 5,743,900 | | 712,433 | | | | 6,456,333 |
| Summit | 259,912 | | 486,972 | | | 5,277,983 | 6,024,867 |
| Total | 18,724,095 | 67,700 | 26,466,369 | 407,007 | 326,521 | 23,687,597 | 69,679,289 |

## ZINC.

In 1911 the marketed zinc ores from Colorado contained 94,607,456 pounds of zinc (figured as spelter and zinc in zinc oxide), valued at $5,392,625, as compared with 77,089,648 pounds, valued at $4,162,841 in 1910, and as compared with 51,210,260 pounds, valued at $2,765,354 in 1909. In 1911, the quantity of zinc yielded was 24,928,167 more pounds than that of lead, and the value was $2,257,057 more than the value of lead, and $1,507,636 more than the value of silver.

Zinc ores furnished 51,388,865 pounds, or 54 per cent of the total zinc yield; lead-zinc ores, 38,224,372 pounds, or nearly 40 per cent; and siliceous or dry ores, 4,994,219 pounds, or 5 per cent.

Lake County produced 76 per cent of the State zinc yield, with an output of 71,610,456 pounds, an increase of 15,243,011 pounds for the year. Leadville zinc carbonate shipments, which were only 8,059 tons in 1910, amounted to 83,905 tons of 31.1 per cent zinc in 1911; the tonnage of zinc sulphide decreased from 163,218 tons to 79,376 tons.

Increased production of zinc was also made in Clear Creek, Dolores, Eagle, Gunnison, San Miguel, and Summit counties. Heavy decreases were made in Mineral and San Juan counties, and appreciable decreases in Chaffee and Park counties. After Lake County, Summit and Eagle counties are respectively second and third in the output of zinc.

Zinc output from concentrates in 1911 amounted to 41,262,830 pounds; in crude ore shipped direct, 53,344,626 pounds. In 1910, zinc output from concentrates was three times that in crude ore.

The following tables show the tonnages of zinc ore and concentrates from a market standpoint:

*Zinc ore and concentrates as marketed at the mine or mill, in Colorado, in 1911, by counties and districts, in short tons.*

| County and district. | Classification. | Quantity. | Average crude assay of zinc. |
|---|---|---|---|
| | | | *Per cent.* |
| Chaffee, Fremont, Gunnison, Park, Saguache. | Ore | 2,222 | 36.0 |
| Mineral | Concentrates | 2,044 | 36.3 |
| Lake | Zinc (lead) suphide ore [a] | 79,376 | 23.3 |
| | Zinc carbonate ore | 83,905 | 31.1 |
| Eagle and Summit | Concentrates | 19,302 | 39.8 |
| Clear Creek and Gilpin | Ore, concentrates, and middlings [b] | 2,752 | 32.0 |
| San Juan region: Dolores (ore), Hinsdale (concentrates), San Juan (concentrates), San Miguel (concentrates). [c] | Ore and concentrates | 13,455 | 27.0 |
| Total | Ore, concentrates, and middlings | 203,056 | 28.7 |
| SUMMARY. | | | |
| Lake | Crude ore | 163,281 | 27.6 |
| All other counties | Ore, concentrates, and middlings | 39,775 | 34.6 |
| Total | do | 203,056 | 28.7 |

[a] The bulk concentrated at Leadville, Canon City, Pueblo, and Denver; the remainder to zinc smelters and zinc-oxide plants, chiefly in Kansas and Oklahoma. Concentrates produced range from 40 to 50 per cent zinc.
[b] Reconcentrated at Western Chemical Co., Denver.
[c] Reconcentrated and smelted at plant of United States Zinc Co., Pueblo.

As regards the Leadville zinc ore, it will be noted that the average percentage of zinc in the carbonate ore shipped to smelters was 31.1 per cent, which is about the lowest limit for marketable zinc carbonate ore, the lowest shipment noted being 26 per cent and the highest 40 per cent; that the zinc (lead) sulphide ore averaged 23.3 per cent, which is also practically the percentage in ore milled, representing a range from 28 per cent down to 14 per cent. Ore sold to the Western Chemical Co., in Denver, and concentrated, ranged from 30 per cent to 14 per cent. Sulphide zinc ore to smelters averaged about 30 per cent, some shipments being as low as 28 per cent, and a considerable tonnage of lead-zinc ore to a zinc oxide plant averaged about the same percentage in zinc as the concentrating ore.

Some shipments of crude zinc ore from Georgetown, Clear Creek County, averaged from 50 to 53 per cent zinc, and most of the concentrates averaged over 40 per cent, but a considerable tonnage of zinc-lead middlings from Georgetown and Idaho Springs to the Western Chemical Co. averaged less than the average in Leadville milling ore. There is considerable lead-zinc ore from Georgetown carrying zinc up to 36 per cent which brings a better price when sold on a lead basis, because of the high silver and lead content in the ore. The Eagle and Summit zinc sulphide concentrates of good tenor of zinc and low gold and silver contents are shipped to the gas belt of Kansas and Oklahoma. The complex sulphide concentrates of San Juan and San Miguel counties, usually carrying appreciable quantities of gold, silver, copper, and lead, are shipped to the United States Zinc Co., at Pueblo, that plant being prepared to handle the concentrates

either by further concentration or by smelting direct, and also being at some advantage in handling lead and iron concentrates and residues because of the proximity of associated lead smelters.

The list of Colorado mills, published elsewhere in this report, shows the various processes of separating the zinc, lead, and iron minerals from the complex sulphides. The American Zinc Extraction Co.'s mill at Leadville formerly handled much of the Leadville sulphide zinc ore by magnetic separation, followed by wet concentration, but this mill was closed early in 1911. The Empire Zinc Co.'s plant at Canon City also treats much of this ore, as well as some from other counties, by magnetic separation, but did not handle as large a tonnage in 1911 as in 1910, owing to changes being made in the process and to construction work toward enlarging the plant. At the Eagle Co.'s mill, at Red Cliff, the ore is first roasted and the iron is then separated magnetically, the zinc being separated from the lead by wet concentration. At the Wilson mill, at Robinson, Summit County, a somewhat similar process is used. The Wellington mill, by wet concentration, makes a lead and a zinc concentrate, and also a zinc-iron middling. For separating the iron from the last product, a roasting and magnetic plant was being built in 1911. The Clear Creek and Gilpin County zinc concentrates are the product from wet concentration. The product of San Juan and San Miguel counties is all by wet concentration, but in 1911 a magnetic plant was being built at the Sunnyside mine, in San Juan County, to separate the iron from zinc-iron middlings. At the Tomboy mine, in San Miguel County, the magnetic plant was not used in 1911. The Mineral County product is all by wet milling. At the Western Chemical Co.'s plant, at Denver, part of the sulphur obtained is utilized in the manufacture of sulphuric acid, the roasted residue then being treated magnetically and by wet concentration.

*Source of zinc product in Colorado in 1911, by kinds of ore, by counties, in pounds.*

| County. | Dry and siliceous gold and silver ores. | Zinc ores. | Lead-zinc ores. | Total. |
|---|---|---|---|---|
| Chaffee | | 200,509 | | 200,509 |
| Clear Creek | | 793,810 | 623,734 | 1,417,544 |
| Dolores | | | 525,333 | 525,333 |
| Eagle | | | 5,097,597 | 5,097,597 |
| Fremont | | 140,526 | | 140,526 |
| Gilpin | 23,088 | | | 23,088 |
| Gunnison | | 48,895 | 508,561 | 557,456 |
| Hinsdale | | | 36,439 | 36,439 |
| Lake | | 49,612,673 | 21,997,783 | 71,610,456 |
| Mineral | | | 1,258,561 | 1,258,561 |
| Park | | 407,772 | | 407,772 |
| Saguache | | 46,561 | | 46,561 |
| San Juan | 1,585,043 | 24,438 | 614,870 | 2,224,351 |
| San Miguel | 3,386,088 | | | 3,386,088 |
| Summit | | 113,681 | 7,561,494 | 7,675,175 |
| Total | 4,994,219 | 51,388,865 | 38,224,372 | 94,607,456 |

*Zinc production [a] in Colorado, since the first tonnage of any important quantity was shipped,[b] 1902–1911, in pounds.*

| Year. | Quantity. | Average price per pound. | Value. |
|---|---|---|---|
| 1902 | 52,582,510 | $0.048 | $2,523,960 |
| 1903 | 80,616,000 | .054 | 4,353,264 |
| 1904 | 64,976,235 | .051 | 3,313,788 |
| 1905 | 81,198,944 | .059 | 4,790,738 |
| 1906 | 85,488,901 | .061 | 5,214,823 |
| 1907 | 85,018,157 | .059 | 5,016,071 |
| 1908 | 30,130,002 | .047 | 1,416,110 |
| 1909 | 51,210,260 | .054 | 2,765,354 |
| 1910 | 77,089,648 | .054 | 4,162,841 |
| 1911 | 94,607,456 | .057 | 5,392,625 |
| Total and average | 702,918,113 | .055 | 38,949,574 |

[a] Estimated recovery from zinc ores: 1902–1908, estimated by Bureau of Mines, Colorado, from smelting companies; 1908–1911, United States Geological Survey figures as calculated from reports from the mines and smelting companies.

[b] Small quantities were shipped prior to 1902. See history of the zinc industry in Colorado. Mine Science, July 27, 1911, p. 85.

## ORE TONNAGES AND METAL CONTENTS.

*Subdivision of crude ore sold or treated in Colorado in 1911, by counties, in short tons.*

| County. | Dry and siliceous gold and silver ores. | Copper ores. | Lead ores. | Zinc ores. | Copper-lead ores. | Lead-zinc ores. | Total. |
|---|---|---|---|---|---|---|---|
| Boulder | 15,320 | 21 | 475 | ..... | ..... | ..... | 15,816 |
| Chaffee | 264 | 164 | 6,579 | 398 | 54 | ..... | 7,459 |
| Clear Creek | 68,397 | 2,938 | 5,044 | 12,642 | 86 | 16,667 | 105,774 |
| Custer | 3,609 | 2 | 59 | ..... | ..... | ..... | 3,670 |
| Dolores | 1,900 | 6 | 473 | ..... | 24 | 873 | 3,276 |
| Eagle | 4,952 | 11 | 622 | ..... | ..... | 27,592 | 33,177 |
| Fremont | ..... | ..... | ..... | 231 | 151 | ..... | 382 |
| Gilpin | 101,325 | 1,500 | 206 | ..... | 7 | ..... | 103,038 |
| Gunnison | 10,499 | 2 | 527 | 95 | ..... | 803 | 11,926 |
| Hinsdale | 155 | 34 | 2 | ..... | 32 | 500 | 723 |
| Lake | 217,510 | 12,963 | 44,413 | 96,223 | 232 | 67,078 | 438,419 |
| La Plata | 9,594 | 464 | ..... | ..... | ..... | ..... | 10,058 |
| Mineral | 20,041 | ..... | 363 | ..... | ..... | 45,528 | 65,932 |
| Montezuma | ..... | 1 | ..... | ..... | ..... | ..... | 1 |
| Ouray | 130,624 | 53 | 2,460 | ..... | 115 | ..... | 133,252 |
| Park | 1,471 | 18 | 3,659 | 628 | 4 | ..... | 5,780 |
| Pitkin | 7,698 | ..... | 76,385 | ..... | ..... | 4,740 | 88,823 |
| Saguache | 23 | 16 | 47 | 67 | 31 | ..... | 184 |
| San Juan | 82,333 | 23 | 13,130 | 372 | 662 | 11,568 | 108,088 |
| San Miguel | 428,043 | 5 | 1,306 | ..... | ..... | ..... | 429,354 |
| Summit | 13,445 | ..... | 3,234 | 189 | ..... | 39,036 | 55,904 |
| Teller | 756,900 | ..... | ..... | ..... | ..... | ..... | 756,900 |
| Total, 1911 | [a] 1,874,103 | 18,221 | 158,984 | 110,845 | 1,398 | 214,385 | 2,377,936 |
| Total, 1910 | 1,957,379 | 15,078 | 133,323 | 82,251 | 2,219 | 244,414 | 2,434,664 |
| Increase (+) or decrease (−) | −83,276 | +3,143 | +25,661 | +28,594 | −821 | −30,029 | −56,728 |
| Average recovered value in gold and silver per ton | $11.00 | $19.58 | $6.53 | $0.30 | $47.28 | $2.16 | $9.49 |

[a] Includes 1,292,012 tons of gold ore; 178,297 tons of silver ore; 403,794 tons of gold and silver ore. Oxidized ores include 4,876 tons of gold ore; 47,314 tons of silver ore; 46,847 tons of gold and silver ore. Sulphide ores include 1,287,136 tons of gold ore; 130,983 tons of silver ore; 356,947 tons of gold and silver ore. Oxidized silver ores include 40,574 tons of iron-manganese ore and 6,740 tons of siliceous ore.

The ores of San Miguel and Teller counties, although mostly sulphide, contain much mixed oxide and sulphide ores, classified here as sulphide.

*Contents of dry and siliceous ores sold or treated in Colorado in 1911, by counties.*

| County. | Tonnage. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Boulder | 15,320 | 7,551.88 | 44,962 | 21,998 | 54,072 | ..... |
| Chaffee | 264 | 71.21 | 2,399 | 419 | 8,537 | ..... |
| Clear Creek | 68,397 | 19,705.19 | 152,902 | 319,767 | 516,598 | ..... |
| Custer | 3,609 | 267.70 | 12,776 | 1,356 | 4,940 | ..... |
| Dolores | 1,900 | 343.01 | 25,461 | ..... | 1,785 | ..... |
| Eagle | 4,952 | 1,887.91 | 60,110 | 64,886 | 172,092 | ..... |
| Gilpin | 101,325 | 34,773.13 | 271,129 | 733,479 | 1,166,318 | 23,088 |
| Gunnison | 10,499 | 6,601.32 | 13,158 | 5,463 | 202,219 | ..... |
| Hinsdale | 155 | 147.15 | 1,983 | 1,078 | 3,322 | ..... |
| Lake | 217,510 | 43,109.56 | 2,199,024 | 2,671,794 | 3,014,019 | ..... |
| La Plata | 9,594 | 13,880.58 | 68,167 | 595 | 1,511 | ..... |
| Mineral | 20,041 | 1,035.06 | 481,994 | 13,735 | 1,104,981 | ..... |
| Montezuma | ..... | .77 | 1 | ..... | ..... | ..... |
| Ouray | 130,624 | 92,846.99 | 398,283 | 525,757 | 2,982,838 | ..... |
| Park | 1,471 | 686.90 | 13,264 | 3,539 | 29,081 | ..... |
| Pitkin | 7,698 | 15.71 | 149,681 | ..... | 156,885 | ..... |
| Saguache | 23 | 5.48 | 987 | 436 | 526 | ..... |
| San Juan | .82,333 | 13,259.49 | 182,477 | 273,774 | 3,300,559 | 1,585,043 |
| San Miguel | 428,043 | 118,318.76 | 906,240 | 955,588 | 5,743,900 | 3,386,088 |
| Summit | 13,445 | 776.62 | 53,245 | 20,412 | 259,912 | ..... |
| Teller | 756,900 | 510,968.34 | 57,783 | ..... | ..... | ..... |
| Total | 1,874,103 | 866,252.76 | 5,096,026 | 5,614,076 | 18,724,095 | 4,994,219 |

*Contents of copper ores sold or treated in Colorado in 1911, by counties.*

| County. | Tonnage. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Pounds.* | *Pounds.* |
| Boulder | 21 | 9.64 | 240 | 2,269 | ..... |
| Chaffee | 164 | 5.62 | 397 | 22,743 | ..... |
| Clear Creek | 2,938 | 2,320.27 | 38,656 | 203,633 | ..... |
| Custer | 2 | .03 | 133 | 284 | ..... |
| Dolores | 6 | .12 | 2,704 | 307 | ..... |
| Eagle | 11 | 6.68 | 115 | 605 | ..... |
| Gilpin | 1,500 | 2,705.04 | 15,953 | 214,946 | ..... |
| Gunnison | 2 | .26 | 58 | 373 | ..... |
| Hinsdale | 34 | 8.71 | 1,699 | 10,069 | ..... |
| Lake | 12,963 | 3,401.58 | 278,184 | 1,110,090 | 64,762 |
| La Plata | 464 | ..... | 1,271 | 73,133 | ..... |
| Montezuma | 1 | ..... | 5 | 183 | ..... |
| Ouray | 53 | 6.10 | 1,251 | 6,577 | 2,218 |
| Park | 18 | ..... | 6 | 3,039 | ..... |
| Saguache | 16 | 2.54 | 615 | 980 | ..... |
| San Juan | 23 | 3.75 | 1,100 | 2,726 | 720 |
| San Miguel | 5 | 1.74 | 263 | 290 | ..... |
| Total | 18,221 | 8,472.08 | 342,550 | 1,652,247 | 67,700 |

*Contents of lead ores sold or treated in Colorado in 1911, by counties.*

| County. | Tonnage. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Pounds.* | *Pounds.* |
| Boulder | 475 | 332.02 | 8,551 | 3,485 | 91,883 |
| Chaffee | 6,579 | 2,817.01 | 88,498 | 60,676 | 957,219 |
| Clear Creek | 5,044 | 1,968.83 | 114,150 | 88,757 | 1,565,058 |
| Custer | 59 | 1.23 | 270 | ..... | 12,571 |
| Dolores | 473 | 19.08 | 15,813 | 1,204 | 343,706 |
| Eagle | 622 | 6.82 | 48,028 | 1,117 | 141,964 |
| Gilpin | 206 | 165.08 | 5,166 | 856 | 71,200 |
| Gunnison | 527 | 334.07 | 5,499 | 528 | 148,557 |
| Hinsdale | 2 | .10 | 289 | 79 | 343 |
| Lake | 44,413 | 6,968.80 | 338,007 | 126,622 | 6,887,194 |
| Mineral | 363 | 24.06 | 6,060 | ..... | 32,082 |
| Ouray | 2,460 | 1,099.50 | 105,531 | 24,537 | 953,129 |
| Park | 3,659 | 978.18 | 55,555 | 17,271 | 893,415 |
| Pitkin | 76,385 | ..... | 291,636 | ..... | 10,647,635 |
| Saguache | 47 | 1.87 | 2,009 | 271 | 25,629 |
| San Juan | 13,130 | 2,722.85 | 63,722 | 149,357 | 2,495,379 |
| San Miguel | 1,306 | 93.81 | 94,331 | 15,186 | 712,433 |
| Summit | 3,234 | 232.11 | 22,479 | 2,476 | 486,972 |
| Total | 158,984 | 17,765.42 | 1,265,594 | 492,422 | 26,466,369 |

*Contents of zinc ores sold or treated in Colorado in 1911, by counties.*

| County. | Tonnage. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Chaffee | 398 | ..... | ..... | ..... | ..... | 200,509 |
| Clear Creek | 12,642 | 27.01 | 46,274 | ..... | 339,854 | 793,810 |
| Fremont | 231 | .49 | 137 | 3,596 | ..... | 140,526 |
| Gunnison | 95 | ..... | ..... | ..... | ..... | 48,895 |
| Lake | 96,223 | 135.17 | 8,299 | 3,763 | 36,058 | 49,612,673 |
| Park | 628 | ..... | ..... | ..... | ..... | 407,772 |
| Saguache | 67 | ..... | 668 | 850 | 24,854 | 46,561 |
| San Juan | 372 | 1.87 | 591 | 3,674 | 6,241 | 24,438 |
| Summit | 189 | ..... | ..... | ..... | ..... | 113,681 |
| Total | 110,845 | 164.54 | 55,969 | 11,883 | 407,007 | 51,388,865 |

*Contents of copper-lead ores sold or treated in Colorado in 1911, by counties.*

| County. | Tonnage. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Pounds.* | *Pounds.* |
| Chaffee | 54 | ..... | 757 | 4,610 | 35,895 |
| Clear Creek | 86 | 155.56 | 1,397 | 7,293 | 43,668 |
| Dolores | 24 | .47 | 292 | 1,478 | 4,268 |
| Fremont | 151 | 8.12 | 1,208 | 10,380 | 19,904 |
| Gilpin | 7 | 7.88 | 407 | 959 | 1,838 |
| Hinsdale | 32 | 5.09 | 2,572 | 1,834 | 6,179 |
| Lake | 232 | 100.28 | 7,355 | 17,683 | 27,875 |
| Ouray | 115 | 521.75 | 7,735 | 7,402 | 11,637 |
| Park | 4 | .04 | 198 | 367 | 593 |
| Saguache | 31 | 14.88 | 385 | 2,447 | 23,547 |
| San Juan | 662 | 67.98 | 68,005 | 38,572 | 151,117 |
| Total | 1,398 | 882.05 | 90,311 | 93,025 | 326,521 |

*Contents of lead-zinc ores sold or treated in Colorado in 1911, by counties.*

| County. | Tonnage. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Clear Creek | 16,667 | 854.93 | 84,536 | 30,918 | 860,044 | 623,734 |
| Dolores | 873 | 3.28 | 11,932 | 299 | 351,485 | 525,333 |
| Eagle | 27,592 | 87.97 | 7,856 | ..... | 541,833 | 5,097,597 |
| Gunnison | 803 | 12.06 | 13,800 | 3,564 | 281,157 | 508,561 |
| Hinsdale | 500 | 24.22 | 1,210 | 8,636 | 108,801 | 36,439 |
| Lake | 67,078 | 1,114.87 | 176,427 | 87,552 | 8,469,181 | 21,997,783 |
| Mineral | 45,528 | 7,609.49 | 57,265 | 19,649 | 6,537,493 | 1,258,561 |
| Pitkin | 4,740 | 10.51 | 9,455 | 7,408 | 279,814 | ..... |
| San Juan | 11,568 | 209.38 | 9,703 | 2,809 | 979,806 | 614,870 |
| Summit | 39,036 | 288.64 | 103,865 | ..... | 5,277,983 | 7,561,494 |
| Total | 214,385 | 10,215.35 | 476,049 | 160,835 | 23,687,597 | 38,224,372 |

## MINING INDUSTRY OF COLORADO IN 1911.

A review of the sources of the gold, silver, copper, lead, and zinc output of Colorado for 1910–11, according to the classes of ore and method of treatment, shows that in 1911, as compared with 1910, there was a smaller tonnage of ore sent to amalgamating, cyaniding, and chlorination mills, with less gold in bullion, but a slight increase in silver content. A slightly increased tonnage was sent to mills for concentration only, but the tonnage of concentrates from all classes of mills was less than in 1910, and the content of the concentrates was less in every metal except copper. With the exception of zinc carbonate ore, the tonnage of ore shipped directly to smelters decreased.

From a metallurgical standpoint, it was found that 77 per cent (as compared with 79 per cent in 1910 and with 76 per cent in 1909) of the tonnage was milled; that 10.9 per cent of this tonnage, or 8 per cent of the total tonnage, was the resulting tonnage in concentrates which were treated at smelters, and that 23 per cent of the ore (as compared with 21 per cent in 1910 and with 24 per cent in 1909) was sent crude direct to smelters, a total percentage treated by the smelters of 31 per cent (the same as in 1909 and in 1910) of the total tonnage. It is found, therefore, that smelters treating the same percentage of a smaller tonnage treated a decreased tonnage in 1911, and recovered 33 per cent of the gold, nearly 95 per cent of the silver, and all the copper, lead, and zinc, or 60 per cent of the total value of the metals from deep mines.

The smelting situation in 1911 in Colorado remained practically as it was at the close of 1910. The Globe, Leadville, and Pueblo smelters were operated continuously, but, as has been the case for several years, not at full capacity. Owing to the floods in the San Juan region and the consequent damage to the railroads, ore from Silverton, Rico, and Telluride was not available, and the Durango smelter was closed in November for the winter. The Salida smelter was active during the year. The semipyritic plant at Golden was in operation almost continuously until November, and treated a larger tonnage than in 1910. The United States Zinc Co.'s plant at Pueblo was steadily operated. The United States Smelting Co.'s zinc-oxide plant at Canon City, closed in October, 1909, was not reopened as a custom plant, but some experimental work toward the treatment of the slag dump was essayed at the beginning of 1912.

To the Salida plant of the Ohio & Colorado Smelting Co. have been added three Godfrey mechanical roadsters and Dwight-Lloyd sintering machines. The Huntington-Heberlein roasters are used at Leadville and Pueblo.

The following list gives the smelting plants in Colorado in 1911:

*List of active smelting plants in Colorado in 1911.*

| City. | Plant. | Owner. |
|---|---|---|
| Denver | Globe | American Smelting & Refining Co. |
| Pueblo | Pueblo | Do. |
| Pueblo[a] | United States Zinc Co | Do. |
| Leadville | Arkansas Valley | Do. |
| Durango[b] | Durango | Do. |
| Salida | | Ohio & Colorado Smelting & Refining Co. |
| Golden[c] | | North American Smelter & Mines Co. |

[a] Zinc-copper ores.
[b] Temporarily closed, November, 1911.
[c] Closed, November, 1911

The yield of gold from the Cripple Creek district decreased $439,600. Conditions in the district were much the same in 1911 as in 1909 and 1910. Although the Roosevelt tunnel, as originally planned, was completed early in 1911, the subsidence of the water was very slow and it became apparent that the tunnel must be driven farther. Work was resumed in October, with satisfactory results to all except those mines in the far eastern portion of the district. In March the Stratton's Independence mill reached a capacity of 10,000 tons of

dump ore per month, and in December the Portland mill, at Victor, reached over 12,000 tons. A new mill, using the Clancy process, was completed in December on the Ajax property.

The three custom mills at Colorado Springs did not yield as much bullion as in 1910. The Golden Cycle handled the bulk of the ore and the Portland and the United States Reduction and Refining Co.'s plants treated the remainder. The chlorination mill of the Portland plant was being gradually transformed to a cyanide plant. Both the chlorination and the cyanide plants of the United States Reduction & Refining Co. were closed at the end of the year. The use of chlorination in the mills of Colorado thus seems near the end.

Lake County (chiefly Leadville) produced a smaller tonnage, with comparatively small decreases in the yield of gold, silver, and lead, but an increase of 15,243,011 pounds of zinc, making a total increase for the county yield valued at $782,975. The tonnage of zinc carbonate produced, chiefly from Carbonate Hill, but also from Fryer, Breece, Iron, Printer Boy, and Rock Hills, increased from 8,059 tons in 1910 to 83,905 tons in 1911, but the output of zinc sulphide decreased from 163,218 tons to 79,376 tons. The tonnage of iron sulphide produced remained practically stationary, but the tonnage of lead and iron-manganese oxide ores decreased, while output of siliceous ores increased somewhat. The American Zinc Co.'s mill at the portal of the Yak tunnel was closed in July.

The San Juan region—Dolores, La Plata, Ouray, San Juan, and San Miguel Counties combined—showed a decreased yield in all the metals except zinc, San Juan County contributing most heavily to the decrease. For gold, San Juan County showed a decrease of $374,064, Ouray a decrease of $242,889, and La Plata $103,907. The Camp Bird mine, in the Sneffels district, Ouray County, produced a somewhat decreased tonnage, with a material decrease in gold-silver bullion and a decreased tonnage of concentrates. San Juan County output showed heavy decreases for all the metals. San Miguel County's output showed a comparatively small decrease for the year 1911 as compared with the output of 1910, but a considerable increase as compared with the yield of 1909. The upper San Miguel district, in which are the three large properties of the Liberty Bell, Smuggler-Union, and Tomboy Cos. (these yielding 90 per cent and more of the county yield), showed a slight increase for 1911. La Plata County's gold and silver yield showed a material decrease because of litigation between owners of two of its principal properties. Dolores County showed a small total increase for 1911, there being important increases for lead and zinc but decreases for the other metals. Hinsdale County, also part of the San Juan group of counties, showed a heavy decrease for all the metals except zinc; the output of copper, the chief metal produced in the county, fell off heavily. Mineral County (Creede), also part of the San Juan region,[1] has been considered alone. Silver, lead, and zinc yields decreased considerably, while gold made a comparatively large increase.

Boulder County increased the yield of gold bullion and also its ore and concentrate shipments, with an increase in total output. Clear Creek County showed an increased yield of the base metals but a decrease in gold and silver. The lower Clear Creek mines

[1] Cross, Whitman, Silverton folio (No. 120), Geol. Atlas U. S., U. S. Geol. Survey, 1905, p. 1.

showed an increase for all the metals and upper Clear Creek mines showed a decrease for all the metals except zinc. Owing to the closing of all but three custom amalgamating mills near Black Hawk, the Gilpin County bullion yield fell off considerably, but the tonnage of concentrates increased very heavily, particularly from the treatment of ore from the Russell district, the contents showing heavy gains in all the metals, resulting in appreciable increases in total metal output for the county.

The Pitkin County (Aspen) yield of lead and silver decreased. The Summit County gold output from dredge operations decreased, but the production of all the other metals showed an appreciable increase, particularly zinc. This county ranks second in zinc yield. Owing to decreased operations at the London mine, the metal output from Park County ore showed a considerable decrease, although there was an increase from hydraulic placer mines. The total value of the yield from Gunnison County showed a decrease, chiefly from a decrease in gold; lead and zinc yields showing increases. Eagle County's yield, chiefly zinc, showed a considerable increase, there being also increases in the yield of the other metals except copper. Chaffee County made a decreased production for 1911, all the metals except lead decreasing. The gold decrease from this county came from placer mines, owing to the closing of the Twin Lakes placer by injunction obtained by cities below the placer operations against the pollution of Arkansas River.

The following table shows the production of gold, silver, copper, lead, and zinc in Colorado, by counties:

*Mine production of gold, silver, copper, lead, and zinc in 1911 in Colorado, by counties.*

| County. | Producing mines. | Tonnage of deep mines. | Gold. | | Silver. | |
|---|---|---|---|---|---|---|
| | | | Quantity. | Value. | Quantity. | Value. |
| | | *Short tons.* | *Fine ounces.* | | *Fine ounces.* | |
| Boulder | 115 | 15,816 | 7,893.54 | $163,174 | 53,753 | $28,489 |
| Chaffee | 19 | 7,459 | 3,178.92 | 65,714 | 92,098 | 48,812 |
| Clear Creek | 95 | 105,774 | 25,116.64 | 519,207 | 437,841 | 232,056 |
| Costilla | 3 | ..... | 1,056.12 | 21,832 | 96 | 51 |
| Custer | 8 | 3,670 | 268.96 | 5,560 | 13,179 | 6,985 |
| Dolores | 12 | 3,276 | 365.96 | 7,565 | 56,202 | 29,787 |
| Douglas | 2 | ..... | 8.03 | 166 | ..... | ..... |
| Eagle | 11 | 33,177 | 1,991.12 | 41,160 | 116,109 | 61,538 |
| Fremont | 1 | 382 | 8.61 | 178 | 1,345 | 713 |
| Gilpin | 162 | 103,038 | 37,673.19 | 778,774 | 292,659 | 155,109 |
| Gunnison | 20 | 11,926 | 7,016.26 | 145,039 | 32,541 | 17,247 |
| Hinsdale | 6 | 723 | 185.27 | 3,830 | 7,753 | 4,109 |
| Lake | 94 | 438,419 | 54,830.26 | 1,133,442 | 3,007,296 | 1,593,867 |
| La Plata | 19 | 10,058 | 13,880.58 | 286,937 | 69,438 | 36,802 |
| Mesa | 1 | ..... | 1.35 | 28 | ..... | ..... |
| Mineral | 9 | 65,932 | 8,668.61 | 179,196 | 545,319 | 289,019 |
| Montezuma | 2 | 1 | .77 | 16 | 6 | 3 |
| Moffat | 4 | ..... | 239.07 | 4,942 | 21 | 11 |
| Ouray | 31 | 133,252 | 94,474.34 | 1,952,958 | 512,800 | 271,784 |
| Park | 25 | 5,780 | 2,846.00 | 58,832 | 69,072 | 36,608 |
| Pitkin | 11 | 88,823 | 26.22 | 542 | 450,772 | 238,909 |
| Routt | 1 | ..... | 56.74 | 1,173 | 26 | 14 |
| Saguache | 8 | 184 | 24.77 | 512 | 4,664 | 2,472 |
| San Juan | 38 | 108,088 | 16,276.40 | 336,463 | 325,604 | 172,570 |
| San Miguel | 28 | 429,354 | 118,414.31 | 2,447,841 | 1,000,834 | 530,442 |
| Summit | 44 | 55,904 | 13,750.16 | 284,241 | 182,957 | 96,967 |
| Teller | 92 | 756,900 | 510,968.34 | 10,562,653 | 57,783 | 30,625 |
| Total | 861 | 2,377,936 | 919,220.54 | 19,001,975 | 7,330,168 | 3,884,989 |

*Mine production of gold, silver, copper, lead, and zinc in 1911 in Colorado, by counties*—Continued.

| County. | Copper. | | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | *Pounds.* | | |
| Boulder | 27,752 | $3,469 | 145,955 | $6,568 | | | $201,700 |
| Chaffee | 88,448 | 11,056 | 1,001,651 | 45,074 | 200,509 | $11,429 | 182,085 |
| Clear Creek | 650,368 | 81,296 | 3,325,222 | 149,635 | 1,417,544 | 80,800 | 1,062,994 |
| Costilla | | | | | | | 21,883 |
| Custer | 1,640 | 205 | 17,511 | 788 | | | 13,538 |
| Dolores | 3,288 | 411 | 701,244 | 31,556 | 525,333 | 29,944 | 99,263 |
| Douglas | | | | | | | 166 |
| Eagle | 66,608 | 8,326 | 855,889 | 38,515 | 5,097,597 | 290,563 | 440,102 |
| Fremont | 13,976 | 1,747 | 19,904 | 896 | 140,526 | 8,010 | 11,544 |
| Gilpin | 950,240 | 118,780 | 1,239,356 | 55,771 | 23,088 | 1,316 | 1,109,750 |
| Gunnison | 9,928 | 1,241 | 631,933 | 28,437 | 557,456 | 31,775 | 223,739 |
| Hinsdale | 21,696 | 2,712 | 118,645 | 5,339 | 36,439 | 2,077 | 18,067 |
| Lake | 4,017,504 | 502,188 | 18,499,089 | 832,459 | 71,610,456 | 4,081,796 | 8,143,752 |
| La Plata | 73,728 | 9,216 | 1,511 | 68 | | | 333,023 |
| Mesa | | | | | | | 28 |
| Mineral | 33,384 | 4,173 | 7,674,556 | 345,355 | 1,258,561 | 71,738 | 889,481 |
| Montezuma | 183 | 23 | | | | | 42 |
| Moffat | | | | | | | 4,953 |
| Ouray | 564,273 | 70,534 | 3,949,822 | 177,742 | | | 2,473,018 |
| Park | 24,216 | 3,027 | 923,089 | 41,539 | 407,772 | 23,243 | 163,249 |
| Pitkin | 7,408 | 926 | 11,084,334 | 498,795 | | | 739,172 |
| Routt | | | | | | | 1,187 |
| Saguache | 4,984 | 623 | 74,556 | 3,355 | 46,561 | 2,654 | 9,616 |
| San Juan | 470,912 | 58,864 | 6,933,822 | 312,022 | 2,224,351 | 126,788 | 1,006,707 |
| San Miguel | 971,064 | 121,383 | 6,456,333 | 290,535 | 3,386,088 | 193,007 | 3,583,208 |
| Summit | 22,888 | 2,861 | 6,024,867 | 271,119 | 7,675,175 | 437,485 | 1,092,673 |
| Teller | | | | | | | 10,593,278 |
| Total | 8,024,488 | 1,003,061 | 69,679,289 | 3,135,568 | 94,607,456 | 5,392,625 | 32,418,218 |

*Tonnage of ore sold or treated, number of deep mines producing, and average value per ton of ore from deep mines in Colorado in 1910 and 1911, by counties.*

| County. | Total ore sold or treated. | | | Number of deep mines producing. | | Average total value per ton. | |
|---|---|---|---|---|---|---|---|
| | 1910 | 1911 | Increase (+) or decrease (—). | 1910 | 1911 | 1910 | 1911 |
| | *Short tons.* | *Short tons.* | *Short tons.* | | | | |
| Boulder | 14,083 | 15,816 | + 1,733 | 85 | 115 | $12.04 | $12.75 |
| Chaffee | 12,496 | 7,459 | — 5,037 | 23 | 17 | 20.29 | 23.60 |
| Clear Creek | 109,954 | 105,774 | — 4,180 | 147 | 91 | 9.33 | 10.03 |
| Custer | 7,052 | 3,670 | — 3,382 | 9 | 8 | 2.20 | 3.69 |
| Delta | 2 | | — 2 | 1 | | 92.50 | |
| Dolores | 2,933 | 3,276 | + 343 | 13 | 12 | 29.21 | 30.30 |
| Eagle | 27,761 | 33,177 | + 5,416 | 12 | 10 | 12.27 | 13.26 |
| Fremont | 29 | 382 | + 353 | 1 | 1 | 33.66 | 30.22 |
| Garfield | 92 | | — 92 | 1 | | 40.41 | |
| Gilpin | 83,631 | 103,038 | +19,407 | 157 | 158 | 10.19 | 10.77 |
| Grand | 1 | | — 1 | 1 | | 7.00 | |
| Gunnison | 25,203 | 11,926 | —13,277 | 14 | 16 | 11.84 | 18.65 |
| Hinsdale | 3,468 | 723 | — 2,745 | 12 | 6 | 31.10 | 24.98 |
| Lake | 462,033 | 438,419 | —23,614 | 104 | 94 | 15.92 | 18.58 |
| La Plata | 6,350 | 10,058 | + 3,708 | 8 | 19 | 73.59 | 33.11 |
| Mineral | 62,956 | 65,932 | + 2,976 | 9 | 9 | 16.46 | 13.49 |
| Montezuma | 448 | 1 | — 447 | 2 | 2 | 19.88 | 42.00 |
| Ouray | 111,245 | 133,252 | +22,007 | 24 | 31 | 24.04 | 18.56 |
| Park | 12,329 | 5,780 | — 6,549 | 13 | 22 | 36.71 | 24.02 |
| Pitkin | 89,037 | 88,823 | — 214 | 12 | 11 | 9.57 | 8.32 |
| Rio Grande | 12 | | — 12 | 1 | | 113.42 | |
| Saguache | 296 | 184 | — 112 | 8 | 8 | 38.54 | 52.26 |
| San Juan | 206,272 | 108,088 | —98,184 | 53 | 37 | 9.50 | 9.31 |
| San Miguel | 481,000 | 429,354 | —51,646 | 43 | 28 | 7.57 | 8.35 |
| Summit | 47,040 | 55,904 | + 8,864 | 20 | 35 | 13.27 | 14.91 |
| Teller | 668,941 | 756,900 | +87,959 | 83 | 92 | 16.49 | 14.00 |
| Total | 2,434,664 | 2,377,936 | —56,728 | 856 | 822 | | |
| Average value per ton | | | | | | 13.67 | 13.08 |

## REDUCTION MILLS IN COLORADO.

The following list gives the reduction mills in Colorado in 1911:

*List of reduction mills in[a] Colorado in 1911, by counties.*

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| BOULDER COUNTY. | | | | *Short tons.* |
| Watts | Boulder | Chlorination | Laboratory plant | |
| Wano | Central | Roasting and cyanidation. | Rolls, Merton roaster, cyanide tanks. | 45 |
| Gold Nugget | Gold Hill | Amalgamation and concentration.[b] | 15 stamps | 50 |
| Black Cloud | do | do | 20 stamps, classifiers, concentration tables, settlers, slime concentrators. | 80 |
| Inter Ocean[c] | do | Cyanidation | | 50 |
| Prussian | do | Concentration | | 75 |
| Slide[d] | do | Roasting and cyanidation. | 15 stamps | 50 |
| Colorado Metal & Chemical Co. (Bailey). | Eldora | Cyanidation | Crusher, rolls, tube mill, Portland filter press. | 50 |
| Alton[e] | Cardinal | Amalgamation and concentration. | Crusher, rolls, jigs, 15 stamps, Wilfley and Card tables, Monell slimers. | 25 |
| Colorado-Arizona | Magnolia | Roasting, cyanidation, and concentration. | | 20 |
| Cashier[c] | Sugar Loaf | Concentration | Crusher, rolls, Richards jigs, 5 Card tables. | 75 |
| Gladys | do | Amalgamation and concentration. | 5 stamps, plate, and 1 Wilfley table. | 25 |
| Good Luck[c] | do | Roasting, blanket amalgamation, and cyanidation. | Crusher, rotary drier, roaster, blanket amalgamator, leaching tanks, zinc precipitation. | 50 |
| U. S. Gold Corporation.[f] | do | Cyanidation | | 150 |
| Zophar[g] | do | Amalgamation and concentration. | 10 stamps, 5-foot Huntington mill, 3 Wilfley tables, 3 Monell slimers. | 50 |
| Arcade (Milwaukee) | Ward | do | | |
| Big Five[c] | do | Concentration | | 50 |
| Morning and Evening Star. | do | Amalgamation | | |
| Utica Hill[h] | do | Cyanidation without roasting. | | 35 |
| Ward Success[h] | do | Concentration | | 25 |
| Yellow Aster[e] | do | Amalgamation and concentration. | 20 stamps, tube mill | 40 |
| CHAFFEE COUNTY. | | | | |
| North Fork (or Condor). | Monarch | Concentration | | 30 |
| CLEAR CREEK COUNTY. | | | | |
| Alice Gold Mines Co.[c] | Alice | Amalgamation, concentration. | Crusher, five 850-pound stamps, one Card table. | 20 |
| Lombard | do | do | 20 stamps, plates, tables | 60 |
| Little Lalla | do | Amalgamation | 5 stamps and plate | 25 |
| Santiago[c] | Argentine | Concentration | Crushers, rolls, concentrating tables. | 40 |
| Waldorf (2 mills)[c] | do | do | | 100 and 150 |
| Conqueror[c] | Empire | do | Crusher, 2 sets rolls, jigs, 1 Wilfley table, 3 Frue vanners. | 40 |
| New System | do | Amalgamation, concentration. | Crusher, stamps, amalgamating plates, bumping tables, Wilfley tables. | 35 |

[a] Active, building, or starting in 1911, or future operations probable.
[b] Concentration not used 1911.
[c] Idle in 1911.
[d] Short run but no clean-up 1911.
[e] Trial run, 1911.
[f] Building, 1911.
[g] Burned, 1911.
[h] Experimental, 1911.

*List of reduction mills in Colorado in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| CLEAR CREEK COUNTY—contd. | | | | *Short tons.* |
| Capital | Griffith | Amalgamtion, concentration. | Crushers, two 6-foot Chilean mills, 12 Card tables. | 100 |
| Dives-Pelican | do | Concentration | Crusher, rolls, jigs, tables, vanners. | 200 |
| Mendota | do | do | Hartz jigs, tables | 50 |
| Mineral Chief | do | do | Jigs, tables | 70 |
| Nashotah [a] | do | do | Crusher, rolls, jigs, tables | 100 |
| Scotia | do | Concentration | Crusher, rolls, jigs, tables | 50 |
| Boston tunnel (Kelly). [a] | do | do | Jigs, tables | 50 |
| Malm [b] | do | Dry chlorination | Uncompleted | 50 |
| Terrible [a] | do | Concentration | Jigs and tables | 150 |
| Combination | Idaho | Amalgamation, concentration. | Stamps, plates, tube mill, concentrating tables. | 50 |
| Gem (Newton) | do | Concentration | Stamps, jigs, tables | 150 |
| Gem (Newton Annex). | do | do | do | 200 |
| Hudson | do | Amalgamation, concentration, cyanidation. | 20 stamps, plates, 4 Dorr thickeners, Akins classifier, Callow cone. | 88 |
| Idaho Springs Reduction. | do | Amalgamation, concentration. | 15 1,050-pound stamps, tube mill, Richards classifier, Wilfley, Card, and Deister tables. | (?) 200 |
| Jackson | do | Concentration | Crusher, jigs, Huntington mill, classifier, card tables, round tables, canvas plant. | 100 |
| Lincoln [a] | do | Amalgamation, concentration. | 10 stamps | 50 |
| Little Mattie | do | do | 30 stamps | 75 |
| Mixsell | do | Concentration | Stamps, tables | 30 |
| Stanley | do | Amalgamation, concentration. | Crusher, rolls, jigs, stamps, plates, tables. | 50 |
| Waltham | do | | | |
| Chicago Mountain | Jackson | Amalgamation | 1 stamp, plate | 4 |
| Honest John | do | Amalgamation, concentration. | 5 stamps | 20 |
| Humboldt | do | do | 10 stamps, Wilfley tables | 40 |
| Katie Emmett | do | Amalgamation | 5 stamps | 20 |
| Jo Reynolds [a] | Montana | Concentration | | 40 |
| Syndicate | do | Amalgamation, concentration, cyanide (?). | 30 stamps | 140 |
| Lamartine [a] | Trail Creek | Concentration | Jigs and tables | 50 |
| New Era | do | Amalgamation, concentration. | 10 stamps | 50 |
| CUSTER COUNTY. | | | | |
| Bassick | Querida | Cyanidation | | 100 |
| Marion [c] | Fairview | Concentration | Samson crusher, McFarlane rolls, trommels, tube mill, Callow cones, Richards classifier, Card tables. | 100 |
| DENVER COUNTY. | | | | |
| Western Chemical Manufacturing Co. | Denver | Roast, magnetic separation and wet concentration; sulphuric acid manufacture. | | |
| Dewey | Utah Junction | Roasters and concentrating tables. | | |
| DOLORES COUNTY. | | | | |
| Emma | Dunton | Concentration | 30 stamps | 100 |
| Smuggler-Almonta [a] | do | do | 20 stamps | 60 |
| EAGLE COUNTY. | | | | |
| Iron Mask [d] | Red Cliff | Magnetic separation and wet concentration. | Crusher, rolls, magnetic separators, concentrating tables. | 65 |

[a] Idle in 1911.
[b] See Mines and Minerals, January, 1910, p. 370.
[c] See Parmalee, H. C., Zinc ore dressing in Colorado: Metall. & Chem. Eng., October, 1910, pp. 568–570.
[d] For description see Parmalee, H. C., Zinc ore dressing in Colorado: Metall. and Chem. Eng., September, 1912.

*List of reduction mills in Colorado in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| EL PASO COUNTY. | | | | *Short tons.* |
| "Valley Mills" | Colorado City | Cyanidation, chlorination. | See Teller County | |
| FREMONT COUNTY. | | | | |
| Empire Zinc Co. | Canon City | Magnetic separation | | |
| Florence | Florence | Cyanidation | See Teller County | |
| GILPIN COUNTY. | | | | |
| Clear Creek M. & M. Co. | Black Hawk | Concentration | Canvas tables | |
| Frontenac [a] | do | do | Blake crusher, rolls, trommels, jigs, Cone thickeners. Flood classifiers, 20 Card tables, 2 tube mills, Callow tanks, 4 Deister tables. | 250 |
| Fifty [b] | do | Amalgamation, concentration. | 80 stamps, plate amalgamation, tables. | 350 |
| Gilpin Eureka | Central City | do | 10 stamps, plates, Wilfley tables, vanners, Horn slimers. | 50 |
| Oliver | Black Hawk | do | Stamps, plates, tables | |
| Polar Star | do | do | 40 stamps (in operation), slow drop, bumping tables. | 120 |
| Tucker | do | Concentration | Stamps, jigs, tables, Wilfley tables. | |
| U. P. R. | Central City | Amalgamation, concentration. | 45 stamps, plates, bumping tables, Wilfley tables. | 140 |
| Perigo | Perigo | do | 30 stamps, plates, 12 Gilpin County bumping tables. | 100 |
| Smuggler (or A. K. R.) | Independence | do | 10 stamps, 64 drops to minute, plates, Gilpin County bumping tables, Wilfley tables. | 30 |
| Golden Flint [b] | do | do | 25 stamps, plates, Pierce amalgamator, card tables. | 100 |
| GUNNISON COUNTY. | | | | |
| Maple Leaf | Cochetopa | Amalgamation, concentration. | 8 stamps, plates, 4 Wilfley tables. | 30 |
| Carter | Ohio | do | 20 stamps, plates, tables | 100 |
| Gold Links | do | Concentration, amalgamation. | | 200 |
| Raymond | do | Amalgamation, concentration. | 20 stamps, plates, tables | 100 |
| HINSDALE COUNTY. | | | | |
| Hanna | Galena | Concentration | | 100 |
| JEFFERSON COUNTY. | | | | |
| School of Mines [c] | Golden | Experimental ore dressing. | (c) | 50 |
| LAKE COUNTY. | | | | |
| American Zinc Extraction Co. | Leadville | Magnetic and wet concentration. | White-Howell furnaces, Cleveland-Knowles separators, Richards classifier, Wilfley and Ford tables. [d] | 100–125 |
| Leadville district | do | Concentration | Blake crusher, rolls, trommels, 4 Hartz jigs, classifier, 4 Card tables. [e] | 100 |
| Miller [f] | Twin Lakes | Amalgamation, concentration. | 30 stamps | 100–150 |
| Mount Champion [f] | do | Concentration | | |

[a] Started March, 1911. For flow sheet, see Min. Sci., July 20, 1911, p. 53.
[b] Idle in 1911.
[c] See Min. Sci., Dec. 29, 1910, p. 626.
[d] See Min. and Sci. Press, Jan. 6, 1912, p. 80.
[e] See Mines and Minerals, May, 1912, p. 619.
[f] Building in 1911.

*List of reduction mills in Colorado in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| MINERAL COUNTY.[a] | | | | *Short tons.* |
| Amethyst | Creede | Concentration | Rolls, jigs (Hartz type), Card tables, Chilean mills, trough classifier, Callow tanks, canvas tables. | 100 |
| Humphreys | do | do | Crusher, coarse and fine rolls, trommels, 12 four compartment Hartz jigs, 3 Chilean mills, trough hydraulic classifier, and 12 Wilfley tables. | 250–300 |
| Ridge | do | do | No crusher, disintegrating screen, trommels, 3 four compartment Hartz jigs, 3 Wilfley tables. | 50–60 |
| MONTEZUMA COUNTY. | | | | |
| Doyle[b] | La Plata | Cyanidation | Roaster, cyanide equipment. | 50 |
| OURAY COUNTY. | | | | |
| Barstow | Red Mountain | Concentration | 10 stamps | 50 |
| Atlas | Sneffels | Amalgamation | 20 stamps (10 added late in 1911), plates, Wilfley tables, Callow settlers, Deister tables, Frue vanners, canvas plant. | 100 |
| Camp Bird | do | Amalgamation, concentration, cyanidation. | 60 stamps (1,050-pound), silvered copper plates, 24 Frue vanners, Huntington mills, 11 Wilfley tables, cyanide mill (150 tons.)[c] | 240 |
| Revenue | do | Amalgamation, concentration. | | |
| O. & N | Uncompahgre | do | One 3½-foot Huntington mill, plates, Wilfley table. | |
| Wanakah | do | Concentration | 20 stamps | 80 |
| PARK COUNTY. | | | | |
| Paris | Buckskin | Amalgamation | 20 stamps, plates | 50 |
| PITKIN COUNTY. | | | | |
| Smuggler | Aspen | Concentration | Crusher, rolls, Hartz jigs, pulverizers, classifiers, tables. | 125 |
| Tam O'Shanter[d] | Ashcroft | do | Crusher, rolls, trommels, Hartz jigs, tube mill, 5 concentrating tables, Frue vanners, Richards classifiers, Callow tanks. | 100 |
| PUEBLO COUNTY. | | | | |
| U. S. Zinc Co | Pueblo | Magnetic separation | | |
| SAGUACHE COUNTY. | | | | |
| Rawley | Kerber Creek | Concentration | Crushers, rolls, jigs, tables. | 80 |
| SAN JUAN COUNTY. | | | | |
| Silver Lake | Animas | do | Crushers, trommels, rolls, jigs, classifiers, Wilfley tables, Chilean mill, Wilfley tables, Frue vanners, canvas tables. | 300 |
| North Star | do | Amalgamation, concentration. | | |
| Old Green Mountain. | Animas | Concentration | Crushers, 10 stamps, Wilfley tables. | 50 |

[a] See Parmalee, H. C.—Zinc ore dressing in Colorado; the Creede district: Metall. and Chem. Eng., December, 1910, pp. 677–680.
[b] Idle in 1911.
[c] See description in Min. and Sci. Press, Dec. 31, 1911, p. 866.
[d] See Mines and Minerals, March, 1912, p. 492.

*List of reduction mills in Colorado in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| SAN JUAN COUNTY—continued. | | | | *Short tons.* |
| Green Mountain [a] | do | do | Crusher, rolls, trommels, jigs, 10 card tables. | 100–180 |
| Hercules | do | Amalgamation, concentration. | Blake crusher, rolls, trommels, jigs, Wilfley tables, 40 stamps, plates, Wilfley tables, Frue vanners. | 140 |
| Intersection | do | Concentration | 5 stamps, 1 concentration table, 1 vanner. | 20 |
| Iowa-Tiger | do | do | Crushers, rolls, trommels, jigs, Chilean mill, Wilfley tables, canvas plant. | 125 |
| Old Hundred [a] | do | Amalgamation, concentration. | 40 stamps, plates, tables | 200 |
| Kittimac | Eureka | Concentration | | 50–100 |
| Ledge [b] | do | do | Blake crusher, rolls, trommels, Hartz jigs, Chilean mill, Callow tanks, Richards classifier, 20 Wilfley tables. | 125 |
| Gold King | do | Amalgamation, concentration. | Gates crusher, 80 stamps (950-pound), plates, 32 card tables, 4 tube mills. | 300–400 |
| Gold Prince | do | do | Gates crusher, 100 stamps, (950-pound), plates, classifiers, 70 card tables, 5 tube mills. | 500 |
| Sound Democrat | Eureka | do | | 30 |
| Sunnyside | do | do | 40 stamps, plates, Wilfley tables, Deister tables. Magnetic plant installed 1912; Ruggles-Coles dryer, trommels, Huff electrostatic machine. | 100 |
| Vermilion [b] | do | Concentration | Crusher, rolls, trommels, Hartz jigs, Chile mill, Richards classifier, Callow tanks, 2 Card tables. | 75 |
| SAN MIGUEL COUNTY. | | | | |
| Butterfly-Terrible | Iron Springs | Amalgamation, concentration. | Thirty 1,050-pound stamps, plates, 9 Frue vanners. | 75 |
| Carribeau | do | Concentration | 20 stamps | 45 |
| Lake Superior-Ophir. | do | Amalgamation, concentration. | 20 stamps, plates, Wilfley tables. | 100 |
| Suffolk | do | Amalgamation | 20 stamps, 1 Dorr classifier and 5 Dorr thickeners. | 100 |
| Alta | do | Concentration | 30 stamps, Wilfley tables | 150 |
| Black Bear | Upper San Miguel. | Amalgamation, concentration. | 20 stamps | 100 |
| Cimarron | do | do | 40 stamps | 200 |
| Iona [a] | do | 30 stamps | | 150 |
| Japan Flora | do | Concentration | Rolls, trommels, jigs, Wilfley tables. | 50 |
| Junta | do | Amalgamation | Denver quartz mill | |
| Lewis | do | Concentration | Rolls, jigs, tables | 50 |
| Liberty Bell | Upper San Miguel (at Pandora). | Amalgamation, concentration, cyanidation. | 80 stamps (850-lb.) (stamping in cyanide solution); amalgamation, regrinding in tube mills, concentrating and treating in cyanide plant; 2 Dorr classifiers and 7 thickeners. Moore filter. [c] | 400 |
| Nellie (Thomas mill). | Upper San Miguel. | Amalgamation | 5 stamps, plates (Wilfley tables, 1912). | |
| Smuggler Union | Upper San Miguel (at Pandora). | Amalgamation, concentration, cyanidation. | 140 stamps (1,040-lb.), classifying cones, Butters distributers, 2 Frue and 2 Gates vanners, Wilfley table, 106 canvas tables. [c] Cyanide leaching plant, 4 Dorr thickeners. | 600 |

[a] Idle in 1911.
[b] For description, see Mines and Minerals, October, 1911, pp. 487–489.
[c] See description of mills, Min. and Sci. Press, Mar. 11, 1911, p. 360.

*List of reduction mills in Colorado in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| SAN MIGUEL COUNTY—contd. | | | | *Short tons.* |
| Tomboy | In Savage Basin. | Amalgamation, concentration. | 60 (1,050-lb.) stamps, plates, 12 Frue vanners, 15 Wilfley tables, 1 Dorr thickener, classifiers for slimes, 2 Wilfley tables, 2 Deister tables (Ding electromagnetic separator).[a] | 350 |
| SUMMIT COUNTY. | | | | |
| Wellington[b] | Breckenridge | Concentration | Crushers, 3 sets Morse rolls, Callow screens, six 6-compartment Hartz jigs, 4 Wilfley tables. Roasting and magnetic separator plant under construction. | 100 |
| Arctic[c] | do | Amalgamation concentration. | 10 stamps, 3 concentrating tables. | 40 |
| Excelsior[c] | do | Concentration | Crusher, rolls, Wilfley tables. | 50 |
| Blue Flag[c] | do | do | | 75 |
| St. John | Montezuma | do | Gates crushers, rotary screens, rolls, Forest jigs, sizer, 4 Ford tables, settling tanks. | 600 |
| Pennsylvania | do | do | Crusher, rolls, jigs, tables, Chilean mills, Callow tanks. | 100 |
| Colorado-Toledo[cd] | do | do | No. 5 Austin gyratory crusher, trommels, rolls, jigs, classifier, Card tables. | 100 |
| Kimberly-Wilfley[c] | Kokomo | do | 2 roasters, Ding magnetic separators, Wilfley tables. | Uncompleted. |
| Kokomo Metals Co.[c] | do | do | Ding magnetic separators, Wilfley roasters, Wilfley tables. | |
| International (Wilson).[e] | do | do | Symons No. 5 C gyratory crusher, Fairchild drier, rolls, 5 Dewey (circular multiple hearth) roasters, 5 Fairchild magnetic separators, 9 Wilfley and 2 Card tables. | 125 |
| TELLER COUNTY (CRIPPLE CREEK). | | | | |
| Ajax[f] | Cripple Creek | Cyanidation, Clancy | Crushers, classifiers, crushing in cyanide solution by tube mills, 1 Moore filter plant, zinc dust precipitation. | 200–250 |
| Anaconda[g] | do | Cyanidation | | 100 |
| Blue Flag[g] | do | do | 2 Chilean mills, 4 Dorr thickeners, etc. | 50 |
| Homestake[g] | do | do | | 50 |
| Jo Dandy[g] (Kavanaugh). | do | do | | 100 |
| Isabella | do | do | | 100 |
| Little Giant[g] | do | do | | 50 |
| Portland[h] | do | Concentrating cyanidation. | Blake crushers, rolls, Vezen sampler, 3 Chilean mills, 16 Wilfley tables, 5 Akins classifiers, 3 Dorr thickeners, Dorr classifier, cone tanks, 8 card tables, 1 Deister table, 3 Rothwell thickening tanks, 5 agitating tanks, 5 Portland revolving continuous slime filters, Merrill zinc dust precipitation, etc. | 350 |

[a] See description of mills, Min. and Sci. Press, Mar. 11, 1911, p. 360.
[b] See Min. and Eng. World, Dec. 23, 1911, pp. 1265–1266.
[c] Idle in 1911.
[d] See Min. and Sci. Press, Feb. 18, 1911, pp. 261–262.
[e] See Metall. and Chem. Eng., February, 1911, pp. 91–95.
[f] See Min. and Sci. Press, Jan. 27, 1912, p. 168; also Eng. and Min. Jour., Dec. 2, 1911.
[g] Starting late in 1911 or early in 1912.
[h] See description and flow sheet, Edgerton, Ward, The New Portland mill: Min. Sci., July 28, 1910.

*List of reduction mills in Colorado in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| TELLER COUNTY (CRIPPLE CREEK)—continued. | | | | |
| | | | | *Short tons.* |
| Stratton's Independence.[a] | Cripple Creek | Concentrating cyanidation. | Gates gyratory crusher rolls, Chilean mills, Ovoca classifiers, 20 card tables, 12 Deister tables, 4 suspended vanners, additional card and Deister tables, tube mill. | 350 |
| Wild Horse | do | Cyanidation | | 40–80 |
| MILLS TREATING CRIPPLE CREEK ORE. | | | | |
| Golden Cycle | Colorado City | Roast-cyanidation | 9 Edwards roasters, 9 Dorr classifiers, 5 Dorr thickeners, etc. | 1,000–1,200 |
| Portland | Colorado Springs | Chlorination | | 350 |
| Do | do | Cyanidation | | 350–500 |
| Standard (U. S. R. & R.). | Colorado City | Chlorination | | 400 |
| Colorado (U. S. R. & R.). | do | Cyanidation | | 300 |
| Florence (Union) (U. S. R. & R.). | Florence | do | Tube mills (blankets), 4 Dorr thickeners, Merrill presses, precipitation by zinc dust. | 600–800 |

[a] For description see Min. Mag. (London), Dec., 1911; also Min. and Sci. Press, Jan. 6, 1912, p. 78.

*Tonnage of ore to gold and silver mills and concentrating mills, with quantity of gold and silver contained in bullion produced in Colorado in 1911, by counties.*

| County. | Ore to gold and silver mills. | | | Ore to concentrating mills. |
|---|---|---|---|---|
| | Quantity. | Gold in bullion. | Silver in bullion. | |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Short tons.* |
| Boulder | 7,946 | 1,785.07 | 620 | 62 |
| Chaffee | | 31.88 | 10 | 151 |
| Clear Creek | 40,489 | 3,498.01 | 2,362 | 41,767 |
| Custer | 3,275 | 244.43 | 2,020 | 45 |
| Dolores | | | | 1,845 |
| Eagle | | 5.18 | 1 | 27,592 |
| Fremont | | | | |
| Gilpin | 29,507 | 4,321.68 | 1,125 | 54,646 |
| Gunnison | 10,390 | 2,751.76 | 756 | 417 |
| Hinsdale | | | | 500 |
| Lake | 50 | 2,245.21 | 729 | 62,540 |
| La Plata | 3,000 | 82.29 | 62 | |
| Mineral | | | | 45,528 |
| Montezuma | | .77 | 1 | |
| Ouray | 102,376 | 62,389.22 | 40,315 | 26,682 |
| Park | 150 | 26.10 | 9 | |
| Pitkin | | 13.98 | 620 | 68,085 |
| Saguache | | 3.66 | | |
| San Juan | 62,473 | 5,751.24 | 2,357 | 43,696 |
| San Miguel | 390,568 | 91,123.25 | 319,976 | 37,438 |
| Summit | | 332.53 | 82 | 54,289 |
| Teller | 723,655 | 424,214.22 | 30,558 | |
| Total | 1,373,879 | 598,820.48 | 401,603 | 465,283 |

*Mine production of gold, silver, copper, lead, and zinc from Colorado concentrates in 1911, by counties.*

| County. | Concentrates produced. | | | | | |
|---|---|---|---|---|---|---|
| | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Boulder | 254 | 290.86 | 3,207 | 284 | 31,414 | ..... |
| Chaffee | 4 | ..... | 84 | ..... | 2,219 | ..... |
| Clear Creek | 9,088 | 5,726.01 | 154,697 | 98,923 | 1,660,435 | 1,154,244 |
| Custer | 9 | .62 | 126 | ..... | 5,862 | ..... |
| Dolores | 90 | 251.16 | 14,813 | ..... | 1,003 | ..... |
| Eagle | 7,840 | 87.97 | 7,856 | ..... | 541,833 | 5,097,597 |
| Gilpin | 17,300 | 12,262.46 | 172,413 | 489,433 | 1,123,176 | 23,088 |
| Gunnison | 1,329 | 3,737.62 | 11,148 | 5,238 | 232,447 | 48,895 |
| Hinsdale | 188 | 24.22 | 1,210 | 8,636 | 108,801 | 36,439 |
| Lake | 52,745 | 1,250.04 | 184,045 | 91,108 | 5,576,244 | 20,472,073 |
| La Plata | 100 | 147.25 | 4,112 | ..... | ..... | ..... |
| Mineral | 7,373 | 7,609.49 | 57,265 | 19,649 | 6,537,493 | 1,258,561 |
| Ouray | 17,387 | 30,252.80 | 293,843 | 515,150 | 2,973,522 | ..... |
| Pitkin | 17,703 | 12.24 | 111,964 | 7,408 | 8,022,366 | ..... |
| San Juan | 17,916 | 9,558.56 | 204,788 | 404,655 | 6,577,882 | 2,224,351 |
| San Miguel | 25,994 | 27,182.56 | 585,673 | 954,801 | 5,740,535 | 3,386,088 |
| Summit | 22,867 | 558.39 | 158,423 | 16,494 | 5,728,319 | 7,561,494 |
| Teller | 2,823 | 10,865.18 | 1,878 | ..... | ..... | ..... |
| Total | 201,010 | 109,817.43 | 1,967,545 | 2,611,779 | 44,863,551 | 41,262,830 |

*Mine production of gold, silver, copper, lead, and zinc from Colorado crude ore shipped to smelters in 1911, by counties.*

| County. | Crude ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Boulder | 7,808 | 5,817.61 | 49,926 | 27,468 | 114,541 | ..... |
| Chaffee | 7,308 | 2,861.96 | 91,957 | 88,448 | 999,432 | 200,509 |
| Clear Creek | 23,518 | 15,807.77 | 280,756 | 551,445 | 1,664,787 | 263,300 |
| Custer | 350 | 23.91 | 11,033 | 1,640 | 11,649 | ..... |
| Dolores | 1,431 | 114.80 | 41,389 | 3,288 | 700,241 | 525,333 |
| Eagle | 5,585 | 1,896.23 | 108,252 | 66,608 | 314,056 | ..... |
| Fremont | 382 | 8.61 | 1,345 | 13,976 | 19,904 | 140,526 |
| Gilpin | 18,885 | 21,066.99 | 119,117 | 460,807 | 116,180 | ..... |
| Gunnison | 1,119 | 458.33 | 20,611 | 4,690 | 399,486 | 508,561 |
| Hinsdale | 223 | 161.05 | 6,543 | 13,060 | 9,844 | ..... |
| Lake | 375,829 | 51,335.01 | 2,822,522 | 3,926,396 | 12,922,845 | 51,138,383 |
| La Plata | 7,058 | 13,651.04 | 65,264 | 73,728 | 1,511 | ..... |
| Mineral | 20,404 | 1,059.12 | 488,054 | 13,735 | 1,137,063 | ..... |
| Montezuma | 1 | ..... | 5 | 183 | ..... | ..... |
| Ouray | 4,194 | 1,832.32 | 178,642 | 49,123 | 976,300 | ..... |
| Park | 5,630 | 1,639.02 | 69,014 | 24,216 | 923,089 | 407,772 |
| Pitkin | 20,738 | ..... | 338,188 | ..... | 3,061,968 | ..... |
| Saguache | 184 | 21.11 | 4,664 | 4,984 | 74,556 | 46,561 |
| San Juan | 1,919 | 955.52 | 118,453 | 66,257 | 355,940 | ..... |
| San Miguel | 1,348 | 108.50 | 95,185 | 16,263 | 715,798 | ..... |
| Summit | 1,615 | 406.45 | 21,084 | 6,394 | 296,548 | 113,681 |
| Teller | 33,245 | 69,772.14 | 22,072 | ..... | ..... | ..... |
| Total | 538,774 | 188,997.49 | 4,954,076 | 5,412,709 | 24,815,738 | 53,344,626 |

*Subdivision of tonnage and average value per ton of ore in Colorado in 1911, according to methods of treatment, by counties.*[a]

| County. | Ore to amalgamating, cyaniding, or chlorination mills. | | | | Ore to concentrating mills. |
|---|---|---|---|---|---|
| | Quantity. | Average value per ton of— | | | Quantity. |
| | | Gold in bullion. | Silver in bullion. | Gold and silver in bullion. | |
| | *Short tons.* | | | | *Short tons.* |
| Boulder | 7,946 | $4.64 | $0.04 | $4.68 | 62 |
| Clear Creek | 40,489 | 1.79 | .03 | 1.82 | 41,767 |
| Gilpin | 29,507 | 3.03 | .02 | 3.05 | 54,646 |
| Gunnison | 10,390 | 5.47 | .04 | 5.51 | 417 |
| Lake | | | | | 62,540 |
| Mineral | | | | | 45,528 |
| Ouray | 102,376 | 12.60 | .21 | 12.81 | 26,682 |
| Pitkin | | | | | 68,085 |
| San Juan | 62,473 | 1.90 | .02 | 1.92 | 43,696 |
| San Miguel | 390,568 | 3.03 | .43 | 3.46 | 37,438 |
| Summit | | | | | 54,289 |
| Total for State | 1,373,879 | 9.01 | .15 | 9.16 | 465,283 |

| County. | Concentrates produced (lead, lead-zinc, iron, etc.). | | | | | | Total average value per ton. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Average value per ton of— | | | | | |
| | | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | | | | | | |
| Boulder | 254 | $23.67 | $6.69 | $0.14 | $5.57 | ..... | $26.07 |
| Clear Creek | 9,088 | 13.03 | 9.02 | 1.36 | 8.22 | $7.23 | 38.87 |
| Gilpin | 17,300 | 14.65 | 5.28 | 3.54 | 2.92 | .08 | 26.47 |
| Gunnison | 1,329 | 58.14 | 4.44 | .49 | 7.87 | 2.10 | 73.04 |
| Lake | 52,745 | .49 | 1.85 | .22 | 4.76 | 22.12 | 29.44 |
| Mineral | 7,373 | 21.33 | 4.12 | .33 | 39.90 | 9.73 | 75.41 |
| Ouray | 17,387 | 35.96 | 8.96 | 3.70 | 7.70 | ..... | 56.33 |
| Pitkin | 17,703 | .02 | 3.35 | .05 | 20.39 | ..... | 23.81 |
| San Juan | 17,916 | 11.03 | 6.06 | 2.82 | 16.52 | 7.08 | 43.51 |
| San Miguel | 25,994 | 21.62 | 11.94 | 4.59 | 9.94 | 7.42 | 55.51 |
| Summit | 22,867 | .51 | 3.67 | .09 | 11.27 | 18.85 | 34.39 |
| Total for State | 201,010 | 11.29 | 5.19 | 1.63 | 10.04 | 11.70 | 39.85 |

| County. | Total ore milled in 1911, in all classes of mills. | | | | | | Ratio of concentration. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Average value per ton of— | | | | Total average value per ton. | |
| | | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | | | | | | |
| Boulder | 8,008 | $5.36 | $0.25 | ..... | $0.18 | ..... | $5.79 | 31.5 to 1 |
| Clear Creek | 82,256 | 2.32 | 1.01 | $0.15 | .91 | $0.80 | 5.19 | 9.0 |
| Gilpin | 84,153 | 4.07 | 1.09 | .73 | .60 | .02 | 6.51 | 4.9 |
| Gunnison | 10,807 | 12.41 | .58 | .06 | .97 | .26 | 14.28 | 8.1 |
| Ouray | 129,058 | 15.00 | 1.37 | .50 | 1.04 | ..... | 17.91 | 7.4 |
| San Juan | 106,169 | 2.98 | 1.03 | .48 | 2.79 | 1.19 | 8.47 | 5.9 |
| San Miguel | 428,006 | 4.08 | 1.12 | .28 | .60 | .45 | 6.53 | 16.5 |
| Total for State | 1,839,162 | 7.96 | .68 | .18 | 1.10 | 1.28 | 11.20 | 9.1 |

[a] For those counties where individual production will not be exposed.

Values for metals used in making calculations for 1911: Gold, $20.6718+ per fine ounce; silver, $0.53 per fine ounce; copper, $0.125 per pound; lead, $0.045 per pound; zinc, $0.057 per pound.

*Subdivision of tonnage and average value per ton of ore in Colorado in 1911, according to methods of treatment, by counties*—Continued.

| County. | Crude ore shipped to smelters. | | | | | | Total average value per ton. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Average value per ton of— | | | | | |
| | | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | | | | | | |
| Boulder | 7,808 | $15.40 | $3.39 | $0.44 | $0.66 | ..... | $19.89 |
| Chaffee | 7,308 | 8.10 | 6.67 | 1.51 | 6.15 | $1.56 | 23.99 |
| Clear Creek | 23,518 | 13.89 | 6.33 | 2.93 | 3.19 | .64 | 26.98 |
| Custer | 350 | 1.41 | 16.71 | .58 | 1.50 | ..... | 20.20 |
| Dolores | 1,431 | 1.66 | 15.33 | .29 | 22.02 | 20.92 | 60.22 |
| Eagle | 5,585 | 7.02 | 10.27 | 1.49 | 2.53 | ..... | 21.31 |
| Gilpin | 18,885 | 23.06 | 3.34 | 3.05 | .28 | ..... | 29.73 |
| Gunnison | 1,119 | 8.47 | 9.76 | .52 | 16.07 | 25.90 | 60.72 |
| Lake | 375,829 | 2.82 | 3.98 | 1.30 | 1.55 | 7.76 | 17.41 |
| La Plata | 7,058 | 39.98 | 4.90 | 1.31 | .01 | ..... | 46.20 |
| Mineral | 20,404 | 1.07 | 12.68 | .08 | 2.51 | ..... | 16.34 |
| Ouray | 4,194 | 9.03 | 22.58 | 1.46 | 10.48 | ..... | 43.55 |
| Park | 5,630 | 6.02 | 6.49 | .54 | 7.38 | 4.13 | 24.56 |
| Pitkin | 20,738 | ..... | 8.64 | ..... | 6.65 | ..... | 15.29 |
| San Juan | 1,919 | 10.29 | 32.72 | 4.31 | 8.35 | ..... | 55.67 |
| San Miguel | 1,348 | 1.66 | 37.42 | 1.51 | 23.90 | ..... | 64.49 |
| Summit | 1,615 | 5.20 | 6.92 | .48 | 8.27 | 4.01 | 24.88 |
| Total for State | 538,774 | 7.25 | 4.88 | 1.26 | 2.07 | 5.64 | 21.10 |

| County. | Crude ore and concentrates combined shipped to smelters. | | | | | | Total average value per ton. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Average value per ton of— | | | | | |
| | | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | | | | | | |
| Boulder | 8,062 | $15.66 | $3.49 | $0.43 | $0.82 | ..... | $20.40 |
| Clear Creek | 32,606 | 13.65 | 7.08 | 2.49 | 4.59 | $2.48 | 30.29 |
| Gilpin | 36,185 | 19.04 | 4.27 | 3.28 | 1.54 | .04 | 28.17 |
| Gunnison | 2,448 | 35.43 | 6.87 | .51 | 11.62 | 12.98 | 67.41 |
| Lake | 428,574 | 2.54 | 3.72 | 1.17 | 1.94 | 9.52 | 18.89 |
| Mineral | 27,777 | 6.45 | 10.41 | .15 | 12.43 | 2.58 | 32.02 |
| Ouray | 21,581 | 30.73 | 11.60 | 3.27 | 8.24 | ..... | 53.84 |
| Pitkin | 38,441 | .01 | 6.20 | .02 | 12.98 | ..... | 19.21 |
| San Juan | 19,835 | 10.96 | 8.64 | 2.97 | 15.73 | 6.39 | 44.69 |
| San Miguel | 27,342 | 20.63 | 13.20 | 4.44 | 10.63 | 7.06 | 55.96 |
| Summit | 24,482 | .81 | 3.89 | .12 | 11.07 | 17.87 | 33.76 |
| Total for State | 739,784 | 8.35 | 4.96 | 1.35 | 4.24 | 7.29 | 26.19 |

*Tonnage of ore and old tailings to amalgamation, cyanidation, and chlorination mills, with quantity of gold and silver contained in bullion and precipitates, in Colorado, in 1911, by processes.*

| Quantity. | Process. | Gold in bullion. | Silver in bullion. |
|---|---|---|---|
| *Short tons.* | | *Fine ounces.* | *Fine ounces.* |
| | Amalgamation | 145,767.07 | 90,502 |
| a1,582,627 | Chlorination | 160,937.28 | 2,285 |
| | Cyanidation | 298,878.31 | 312,091 |
| 1,582,627 | ..... | 605,582.66 | 404,878 |

aOf this tonnage, 646,894 tons were treated by amalgamation, in some cases followed by cyanidation of tailings, in other cases not followed by cyanidation. The actual tonnage of tailings of this ore therefore is some part of this 646,894 tons, and figures as to actual tonnage of ore and tailings treated are available only for mills treating Cripple Creek ore.

*Production of Cripple Creek district, Colorado, in 1911, by processes.*

| Quantity. | Process. | Gold. | Silver. |
|---|---|---|---|
| *Short tons.* | | *Fine ounces.* | *Fine ounces.* |
| 892,773 | Chlorination | [a]160,291.90 | [a]2,285 |
| | Cyanidation | 270,392.68 | 31,560 |
| ..... | Chlorination and cyanidation | [a]430,684.58 | [a]32,845 |

[a] Includes Boulder County yield, by chlorination, nominal quantity.

*Consumption of quicksilver and cyanide in mills treating Cripple Creek ores, in 1911.*

| Quicksilver. | Potassium cyanide. | Sodium cyanide. |
|---|---|---|
| *Pounds.* (a) | *Pounds.* [b]398,791 | *Pounds.* [b]60,000 |

[a] Some used at Golden Cycle cyanide mill on blanket tables, recovering much gold. Gold thus recovered has, however, been crushed in cyanide and such recovery is here given to cyanidation.

[b] Potassium and sodium cyanide combined were used at a ratio of 0.51 pound cyanide per ton of ore treated, and for every pound used was recovered 0.59 ounce of gold. An interesting comparison of these figures is shown by the chemical consumption at the Liberty Bell mill, Telluride, Colo. (Eng. and Min. Jour., July 20, 1912, p. 111): cyanide, 1.2 pounds; zinc, 0.487 pound; lime, approximately 7 pounds; lead acetate and litharge, 0.415 pound; and sulphuric acid, 0.076 pound per ton of ore milled.

*Consumption of quicksilver and cyanide in Colorado mills, in 1911.*

| Quicksilver. | Potassium cyanide. | Sodium cyanide. |
|---|---|---|
| *Pounds.* [a]13,221 | *Pounds.* [b]510,589 | *Pounds.* [b]248,560 |

[a] Represents 1 pound of mercury for every 48.9 tons of ore, or 1 ounce of mercury for every 3.06 tons of ore and 1 pound of mercury for every 11.03 ounces of gold, or 1 ounce of mercury for every 0.689 ounce of gold.

[b] Represents in combined potassium and sodium cyanide 1 pound of cyanide for 0.39 ounce gold and 0.41 ounce silver, or, to recover 1 ounce gold and practically 1 ounce silver (the gold and silver quantities being nearly alike) required 2.57 pounds of cyanide.

## REVIEW BY COUNTIES.

### BOULDER COUNTY.

*Mine production of gold, silver, copper, and lead in Boulder County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 6,768.19 | $139,911 | 7,893.54 | $163,174 | +1,125.35 | +$23,263 |
| Silver.....do.... | 46,517 | 25,119 | 53,753 | 28,489 | + 7,236 | + 3,370 |
| Copper.....pounds.. | 16,772 | 2,130 | 27,752 | 3,469 | + 10,980 | + 1,339 |
| Lead.....do.... | 53,250 | 2,343 | 145,955 | 6,568 | + 92,705 | + 4,225 |
| Total..... | ..... | 169,503 | ..... | 201,700 | ..... | + 32,197 |

Boulder County produced 15,816 short tons of ore from 115 mines in 1911 as compared with 14,083 tons from 85 mines in 1910. The average recoverable value per ton in 1911 was $12.75, as compared

with $12.04 in 1910, with $15.83 in 1909, with $16.17 in 1908, and with $22.82 in 1907.

The total value of the ore produced in 1911 was $201,700, an increase of $32,197. Gold and silver are the chief products of this county, and the output of both metals showed an increase. The copper and lead yields also increased.

Ore from Boulder County mines in 1911 was about equally divided between smelters and mills. The mills include amalgamation, concentration, chlorination, and cyanidation plants.

*Central district.*—The production of the Central district, near Jamestown, in 1911 was 698 tons, with a total value of $11,381 (chiefly gold), as compared with $5,107 in 1910, with $19,494 in 1909, and with $30,770 in 1908. The bulk of the ore was treated by cyaniding at Jamestown, the remainder going to smelters. Various small lots of high content of gold were sold to a small custom chlorination plant at Boulder. The producing mines were the Earl, Golden Age, Grand Central, Invincible, John Jay, May Belle, Wano group, Rip Van Dam, and Tippecanoe. On the property of the Wano group is a 45-ton roasting and cyanide plant, which was operated for several weeks by lessees.

*Gold Hill district.*—The Gold Hill district in 1911 maintained its place as first in point of value of metallic production. The production from 10,501 tons (as against 7,180 tons in 1910), was $79,325 in gold, 24,435 ounces of silver, 4,118 pounds of copper, and 126,247 pounds of lead, with a total value of $98,472, as compared with $67,723 in 1910, with $56,436 in 1909, and with $69,113 in 1908. There were 51 producing mines in 1911, as against 23 in 1910. A little more than half the tonnage was milled, the rest being shipped crude to smelters. Mill bullion contained about one-sixth of the gold and silver, and crude ore and concentrates the remainder of the metals produced in the district. The Gold Nugget and the Black Cloud mills, both equipped for amalgamation and concentration, were operated, and considerable bullion from this district was also recovered by chlorination at Boulder from various small lots of high gold content. The principal producing mines were the American and Monongahela, Big Horn, Black Cloud, Black Swan group, Cash-Birkin, Emancipation dump, Fairfax, Ingram group, Inter-Ocean, Gold Nugget, Prussian, Richmond, Slide, Victoria dump, and White Eagle group.

*Grand Island district* (*Cardinal, Caribou, Eldora*).—The total value of the output from 8 properties in Grand Island district was $2,726, chiefly silver. The ore was shipped to smelters. Experiments were made in the mill of the Ida Co. on the dump of the Caribou and Poorman mines. The Alton Mining and Milling Co., at Cardinal, made several trial runs during the year on copper and tungsten ore and continued driving its crosscut tunnel. The Colorado Metal and Chemical Co. remodeled the old chlorination mill above Eldora into a cyanide plant. The Up-to-Date Mining Co., at Caribou, shipped ore early in January, 1912.

*Magnolia district.*—The Magnolia district produced gold and silver in 1911 valued at $13,359, as compared with $4,358 in 1910 and with $12,436 in 1909. The cyanide mill of the Colorado-Arizona Mines Co. was operated on ore from the Cash mine. Other producing mines

were the Enterprise, Fortune, Graphic, Hereafter, K. C., Lois, Mary V., and Poorman. Most of the ore was gold telluride of good commercial smelting grade.

*Sugar Loaf district.*—The Sugar Loaf district produced 1,668 tons, yielding $30,201 in gold, 13,916 ounces of silver, 2,790 pounds of copper, and 8,108 pounds of lead, with a total value of $38,290, as compared with $54,610 in 1910 and with $66,560 in 1909. There were 27 producing mines in both 1911 and 1910. The bulk of the ore was shipped to smelters. The free-milling ore of the Logan mine was treated in a small laboratory amalgamating plant or sold to a custom chlorination plant at Boulder; also a good grade of smelting ore was shipped. Gold telluride ore was shipped from the Alpine Horn mine. The 75-ton concentration mill of the Cashier mine was idle. Ore from the Concord mine was sent to a custom concentration plant and oxidized siliceous ore was shipped from the Dime mine. Ore from the Evening Star mine was shipped to smelters, bullion and concentrates were marketed from the Gladys mill, and ore from the dump of the Gold Lode mine was shipped. The Good Luck mill was idle. A small tonnage of free-milling gold ore from the Orphan Boy mine was amalgamated. Ore from the Tambourine mine was shipped to smelters and to the Zophar mill before that plant burned down; sulphide ore, carrying chiefly silver and some lead and copper, was shipped from the Yellow Pine mine; and small shipments to the smelter were made from other mines, chief of which were the Doss, Herald, Pine Shade, and Nancy. The United States Gold Corporation continued work on its 150-ton cyanide plant.

*Ward district.*—The Ward district in 1911 produced 1,043 tons, yielding $24,828 in gold, 9,553 ounces of silver, 18,654 pounds of copper, and 4,694 pounds of lead, with a total value of $32,434, as compared with $25,238 in 1910 and with $27,741 in 1909. Most of the ore was shipped to smelters. Bullion, crude ore, and concentrates were shipped from the Milwaukee mine and mill, and ore from the mines of the Big Five Co. was shipped to smelters, the 50-ton concentration plant being idle. Crude ore was shipped from the Celestial Extension, Golden Queen, New Market, and White Raven mines. The output from the Morning and Evening Star mine was in the form of bullion and crude ore.

## CHAFFEE COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Chaffee County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 3,732.23 | $77,152 | 3,178.92 | $65,714 | − 553.31 | − $11,438 |
| Silver.....do.... | 182,003 | 98,282 | 92,098 | 48,812 | − 89,905 | − 49,470 |
| Copper.....pounds.. | 226,772 | 28,800 | 88,448 | 11,056 | − 138,324 | − 17,744 |
| Lead.....do.... | 970,523 | 42,703 | 1,001,651 | 45,074 | + 31,128 | + 2,371 |
| Zinc.....do.... | 438,539 | 23,681 | 200,509 | 11,429 | − 238,030 | − 12,252 |
| Total..... | ..... | 270,618 | ..... | 182,085 | ..... | − 88,533 |

Deep mines in Chaffee County in 1911 produced 7,459 tons of ore, yielding $65,714 in gold, 92,098 fine ounces of silver, 88,448 pounds of copper, 1,001,651 pounds of lead, and 200,509 pounds of zinc, with total value of $182,085. In 1910 deep mines produced 12,496 tons, yielding $60,142 in gold, 181,846 fine ounces of silver, 226,772 pounds of copper, 970,523 pounds of lead, and 438,539 pounds of zinc, with a total value of $253,523. In 1911 placer mines yielded $5,893 in gold and 47 ounces of silver, as compared with $17,010 in gold and 157 ounces of silver in 1910. Thus it is seen that the decrease for the county in gold output is due to the decrease in placer output. The variance in the output of the other four metals is attributable to changes in class of ore marketed, dry, copper, and zinc ores decreasing heavily, and lead ores increasing materially. With the exception of a small quantity of metallic gold marketed, and of a small tonnage sent to a concentrating mill, all the ore in 1911 was sent direct to smelters.

There were 17 productive deep mines and two placers. The production of the Chalk Creek district trebled in value, but the yield of the Monarch district, first in point of output, was only a little more than one-half its output of 1910, and the yield from the Turret copper district was small as compared with the production in 1910.

*Chalk Creek district.*—Shipments of lead ore from the Chalk Creek district increased heavily in 1911. The principal mine is the Mary Murphy, the ore of which is a sulphide (in part slightly oxidized) of zinc, lead, iron, and copper in a gangue of quartz and rhodonite carrying gold and silver. The zinc is under the penalty limit. The lower adit was extended to the vein at a depth of 870 feet below the lowest previous workings, and drifts were driven on the vein at that depth. Production in 1911 was entirely from above the third level. Small shipments of lead and dry ores, carrying gold, silver, lead, and some copper were shipped from the Bonner, Comstock, and Flora Bell mines. Development work on the Black Hawk mine developed lead-zinc ore. The Samuel J. Tilden mine was reopened.

*Four Mile district.*—A small yield of placer gold was made from the Derillo placer in the Four Mile district.

*Granite district.*—Owing to a lawsuit instituted by the cities of Pueblo, Canon City, and Salida against the Twin Lakes Placer Co., of the Granite district, to enjoin that company from operating by hydraulicking, because of pollution of the water supply of these cites, hydraulicking at the Twin Lakes placer was stopped and operations were confined to shoveling into sluice boxes. A greatly decreased output was the result. A small lot of dry ore carrying gold, silver, and lead was shipped from the Margaret mine. Development work was done on the Columbine mine. Driving of the Granite tunnel was continued.

*Monarch district.*—[1] The Monarch is the principal producing district in the county, and in 1911 produced 5,971 tons, yielding $24,693 in gold, 69,917 fine ounces of silver, 63,734 pounds of copper, 802,600 pounds of lead, and 200,509 pounds of zinc, with a total value of $117,262, as compared with $216,011 in 1910, and with $140,915 in 1909.

There were 7 producing mines in this district. The Monarch-Madonna mine was again the chief producer, but with a decreased

[1] See Crawford, R. D., A preliminary report on the geology of the Monarch Mining District, Chaffee County, Colo.: Bull. Colorado State Geol. Survey for 1909, No. 1, 1910.

output.[1] The Taylor Mountain Mining Co. continued to develop its mine and shipped oxidized lead and copper ore.[2] A metallurgical plant at the mine is in prospect. The North Fork Power & Mines Co. shipped ore from its Pride of the West and other mines to its own 30-ton concentration mill, marketing lead concentrates. Shipments of copper-lead, copper, and lead ores were made from the Jewell group, Last Chance, Shamrock, and Silent Friend mines.

*Riverside district.*—Ore carrying gold, silver, copper, and lead from the Mount Harvard mine, and gold-silver ore from the Sunrise mine in Riverside district, were shipped to smelters.

*Turret district (including Sedalia).*—Small shipments were made from the Golden Wonder and Turret-Independence mines in the Turret district. No output was made from the Sedalia copper mine.

## CLEAR CREEK COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Clear Creek County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 25,777.10 | $522,524 | 25,116.64 | $519,207 | − 660.46 | −$3,317 |
| Silver.....do.... | 475,174 | 256,594 | 437,841 | 232,056 | − 37,333 | −24,538 |
| Copper.....pounds.. | 595,795 | 75,666 | 650,368 | 81,296 | + 54,573 | + 5,630 |
| Lead.....do.... | 2,434,476 | 107,117 | 3,325,222 | 149,635 | +890,746 | +42,518 |
| Zinc.....do.... | 1,247,389 | 67,359 | 1,417,544 | 80,800 | +170,155 | +13,441 |
| Total..... | ..... | 1,029,260 | ..... | 1,062,994 | ..... | +33,734 |

The total value of the production of gold, silver, copper, lead, and zinc in Clear Creek County in 1911 was $1,062,994, as compared with $1,029,260 in 1910, an increase for 1911 of $33,734. There were decreases in the output of gold and silver but increases in copper, lead, and zinc. There was an increased yield of gold and silver as bullion, but a decreased content in concentrates and crude ore shipped to smelters. An increased content of copper in crude ore to smelters overbalanced the decreased content in concentrates. Lead production increased both from concentrates and crude ore. The zinc yield was chiefly from concentrates, the content of which for 1911 showed an increase.

The output from the lower Clear Creek mines (Idaho, Jackson, Montana, and Trail districts combined) made a small decrease in tonnage, but increased in the output of all the metals, while upper Clear Creek mines (Argentine, Empire, and Griffith districts combined) made a small increase in tonnage, but decreased in all the metals except zinc, with a decrease in combined values.

There were 91 producing deep mines or groups of mines, as compared with 113 in 1910, and from other mines and prospects a very small tonnage was produced.

Producing placers in 1911 were 4 in number, as compared with 10 in 1910. The yield of placer gold decreased from $3,678 in 1910 to $1,754 in 1911.

[1] For total output of mine see Mineral Resources U. S. for 1910, Pt. I, 1911, p. 403.
[2] See op. cit., p. 403.

The tonnage of ore sold or treated in 1911 was 105,774 short tons, as against 109,954 tons in 1910, against 116,753 tons in 1909, and against 109,672 tons in 1908. The average value per ton in 1911 was $10.03, as compared with $9.33 in 1910, with $8.44 in 1909, and with $9.87 in 1908.

The average gold and silver value per ton of siliceous ore was $7.14, of which $5.96 was gold; of copper ores, $23.28, of which $16.33 was gold; of lead ores, $20.06, of which $8.07 was gold; of zinc ores, $1.98, of which $0.04 was gold; of copper-lead ores, $46, of which $37.40 was gold; and of lead-zinc ores, $3.75, of which $1.06 was gold.

During 1911 the tonnage of Clear Creek County ores treated at amalgamation and cyanide plants in Clear Creek and Gilpin counties was less than in 1910, but the quantity of bullion recovered increased; a slightly increased tonnage was sent to mills for concentration only, with a resultant increase in tonnage of concentrates produced; the tonnage sent crude to smelters also increased.

*Alice (or Yankee) district.*—The Alice district produced a yield valued at $1,991, mostly gold, as compared with $2,728 in 1910, and with $14,330 in 1909. A small tonnage was treated at the Lombard amalgamation and concentration mill, and ore from the Little Lalla mine was treated by amalgamation. Several lots of crude ore were sent from this district to smelters. The large low-grade deposit of disseminated pyrite of the Alice Gold Mills Co. remained unworked in 1911, but in 1912 the Tonapah Mining Co., of Nevada, undertook the sampling and development of the mine, with purchase in prospect.

*Argentine district.*—The Argentine district in 1911, from 5 mines, produced 3,066 short tons, yielding $41,836 in gold, 41,704 ounces of silver, 184,505 pounds of copper, and 288,667 pounds of lead, with a total value of $99,992, as compared with $137,880 in 1910.

The principal producing mine was the Santiago, from which was shipped copper ore carrying appreciable quantities of gold and silver. Crude ore was shipped to smelters from the Josephine, Mary Etta, Morning Star, and Waldorf mines.

*Empire (or Upper Union) district.*—The Empire district in 1911, from 7 mines, produced 1,752 tons, yielding $22,168 in gold, 1,923 ounces of silver, 11,742 pounds of copper, and 1,800 pounds of lead, with a total value of $24,736, as compared with $30,732 in 1910, and with $38,529 in 1909. The greater part of the tonnage was milled, but crude ore shipped to smelters contained more than half of the metal output. Ore from the New System mine was treated at the company's amalgamation and concentration mill, and sent also crude to smelters. The Gold Dirt mine, with output in smelting ore alone, was the chief producer. Shipments of crude ore to smelters were made also from the Bard Creek, Golconda, Columbia-Eureka, Gold Fissure, and Pioneer mines.

*Griffith district.*—The Griffith district in 1911, from 11 mines, produced 40,201 short tons, yielding $47,820 in gold, 169,502 fine ounces of silver, 27,524 pounds of copper, 1,131,444 pounds of lead, and 1,215,351 pounds of zinc, with a total value for the five metals of $261,286, as compared with $277,143 in 1910, with $231,639 in 1909, and with $203,190 in 1908. The output in 1911 was 2,310 tons greater than in 1910. Gold, copper, and zinc yields increased, but silver and lead decreased. Zinc production from this district represented 86 per cent of the county yield.

Of the 40,201 tons of ore sold or treated, 38,189 tons were treated in amalgamation and concentration mills and in mills for concentration only, the larger part of the tonnage going to the latter. There were 3,178 tons of concentrates produced, and these, with 2,012 tons of crude ore, a total of 5,190 tons, were shipped to smelters, and yielded the metals produced in the district, with the exception of the gold and silver saved on the plates.

The Capital Mining & Tunnel Co., at Georgetown, operated the mine and mill steadily, an increased tonnage being treated. The mill is an amalgamating and concentration plant. A small quantity of cyanide was used in addition to the quicksilver in 1911. The product of the mill is gold and silver bullion and lead concentrates, carrying also gold, silver, and copper. Smelting ores shipped in 1911 were chiefly lead and copper-lead ores. Crude and dump ore from the Dives-Pelican-Seven-Thirty group was treated at the Burleigh mill and at the Scotia mill, resulting in a silver-lead concentrate, carrying a little gold, and a zinc concentrate, carrying a little lead, silver, and gold. Crude lead and zinc ore was also shipped direct to smelters. Zinc ore, carrying lead, silver, and some gold, from the Mendota-Frostburg group, was treated at the Mendota concentration mill and yielded lead concentrates, zinc concentrates, and a zinc-iron middling, the latter being sent to the Western Chemical Co., Denver. Lead and zinc ores from the Smuggler mine were treated at the Mendota mill or sent to smelters. Lead-zinc and zinc ores from the Gambetta mine were in part shipped to zinc smelters and in part milled at Idaho Springs. The Mineral Chief concentration mill was operated for a short time. The East and West Griffith mines were operated by lessees.

*Idaho district.*—In this district are included the mines about Idaho Springs, including Banner, Coral, Jackson, Lower Fall River, Payne's Bar, Spanish Bar, and Virginia subdistricts.

In 1911 there were 51,637 tons of ore mined in the Idaho district, as compared with 56,605 tons in 1910 and with 52,564 tons in 1909. The production of metals from deep mines in 1911 was $296,435 in gold, 167,953 ounces of silver, 333,228 pounds of copper, 1,571,755 pounds of lead, and 202,193 pounds of zinc, with a total value for the five metals of $509,358, as compared with $458,703 in 1910, with $530,302 in 1909, and with $707,838 in 1908.

In 1911, of the 51,637 tons mined, 23,464 tons were treated at amalgamating, cyaniding, and concentrating mills, and 16,395 tons were treated at mills for concentrating only, a total to both classes of mills of 39,859 tons, yielding 5,589 tons of concentrates (ratio 7 to 1). These concentrates, and 11,778 tons of crude ore, 17,367 tons in all, were shipped to smelters, and contained all the metals produced by deep mines in the district (with the exception of 2,434.25 fine ounces of gold, valued at $50,320, and 1,750 fine ounces of silver, valued at $928, in mill bullion).

A large tonnage was shipped to mills and smelters from the Edgar and the East and West Belman mines, through the Big Five tunnel. Ore from the Shafter and Refugee mines, worked through a lateral to the Big Five tunnel, was sent chiefly to the amalgamating and cyanide mill of the Hudson Reduction Co. Ore from the Lake mine was mined through the Big Five tunnel and sent to amalgamating and also to concentration mills, and ore from the Specie Payment

mine (worked from the surface) was sent to Black Hawk mills. No ore was mined through the Two Brothers tunnel of this company. In Virginia Canyon the Blue Bell, Champion-Trio, Crystal, Papoose and Victor, and East Lake mines were producers. A small tonnage was mined in the Foxhall tunnel, and lead-zinc ore from the Bride mine was treated at the Gem mill, lead ore going to smelters. The Gem Consolidated mines, worked through the Newhouse tunnel by lessees, yielded an increased tonnage in 1911. This ore was treated at the Hudson plant, at the Gem mill, and crude ore and concentrates produced were sent to smelters. Ore from the Sun and Moon group [1] was shipped to the Golden smelter, and ore from the Franklin and Silver Age mines was also shipped to smelters. Some crude ore from the Little Mattie group, on the south side of Clear Creek, was sent to smelters; but the bulk of the ore was treated at the company's mill. Lead ore was shipped from the Kitty Clyde mine to mills and smelters, but most of the ore from the Stanley mines was concentrated at the company's mill. A small tonnage was shipped to smelters from the Gladstone and from the Josephine group mines; several lots were sent to mills and smelters from the Centennial mine; and crude ore was shipped to smelters from the Kinda mine.

In the Jackson district a small tonnage was treated at the Humboldt mill, and an appreciable tonnage was treated at the Katie Emmett mill. Crude ore was shipped to plants at Idaho Springs or to smelters from the Beaver, Black Eagle, P. T., and Vindicator mines.

*Montana district (Dumont and Lawson).*—The Montana district, in 1911, from 8 mines, produced 420 tons, carrying $4,205 in gold, 10,462 ounces of silver, 12,959 pounds of copper, and 29,378 pounds of lead, with a total value of $12,688, as compared with $8,279 in 1910. Gold-silver-copper ore from the Albro mine was shipped to mills and smelters. Lead and dry ores were shipped to smelters from the Blue Ridge, Commodore, Lost Treasure, Millington, and Plattz mines. Ore to mills and smelters was shipped from the Pioneer and the Syndicate mines.

*Trail Creek district (Lamartine and Freeland).*—The Trail Creek district in 1911, from 9 mines, produced 8,559 tons, yielding $103,116 in gold, 46,158 ounces of silver, 80,400 pounds of copper, and 301,000 pounds of lead, with a total value of $151,175, as compared with $106,114 in 1910. As in 1910, the North American Smelter & Mines Co. was the chief operator, shipping sulphide ores, carrying gold, silver, and copper, from the Donaldson, Magalona, and other mines, to the company's copper-matting plant at Golden. A material tonnage of similar ore and also some lead ore was shipped from the Oneida to the Golden and Globe smelters. Lead ore from the Ben Harrison mine was shipped to concentrating mills and to smelters; lead and copper-lead ore was shipped from the Gum Tree mine to mills and smelters; and dry and lead ores were sent to mills and smelters from the Lamartine and Money Musk mines. Ore from the New Era mine was treated in the company's amalgamating and concentration plant and also shipped to smelters, and ore from the Big Chief mine was sent to the Combination mill at Idaho Springs. Shipments were also made from the Freeland and Silver Horn mines.

[1] The ore from this mine was reported to come from the Clear Creek County side. Surveys show that the ore bodies mined in 1911 lie very close to the Clear Creek-Gilpin line.

### COSTILLA COUNTY.

*Grayback district.*[1]—The Colorado Gold Dredging Co. operated during part of the year its Hammond dredge of the close-connected type, of 54 buckets of 4 cubic feet capacity each, or 2,000 cubic yards per day. A little gold was recovered from the Last Chance placer by sluicing. Assessment work was done on several lode prospects.

### CUSTER COUNTY.

From 8 mines in Custer County in 1911 there were sold or treated 3,670 tons, from which were recovered $5,560 in gold, 13,179 ounces of silver, 1,640 pounds of copper, and 17,511 pounds of lead, with a total value of $13,538, as compared with $15,544 in 1910 and with $27,191 in 1909.

There were decreases in the yield of gold and copper, but increases for silver and lead. No zinc was produced in 1911, as against 6,796 pounds in 1910.

The greater part of the tonnage was dry or siliceous ore. Most of the dry ore was milled; the remainder was shipped to smelters.

Lessees treated ore from the dump of the Bassick mine at Querida in a 100-ton cyanide plant. Silver-lead ore, carrying some gold, was shipped from Silver Cliff.

The Marion Mines & Mill Co., at Fairview, 45 miles southwest of Pueblo, in the Greenhorn Range, continued development of its copper-lead-zinc sulphide ore [2] and construction of mill and power plant.

### DOLORES COUNTY.

Dolores County in 1911 produced 3,276 short tons of ore, yielding $7,565 in gold, 56,202 ounces of silver, 3,288 pounds of copper, 701,244 pounds of lead, and 525,333 pounds of zinc, with a total value for the five metals of $99,263, as against $85,667 in 1910, an increase for 1911 of $13,596. There were appreciable decreases in gold, silver, and copper yields, but important increases for lead and zinc.

*Lone Cone district (Dunton).*—The Emma Mine was the only important producer in the Lone Cone district. Most of the ore from this property (chiefly carrying gold and silver) was concentrated in the company's concentration plant, the remainder being shipped to smelters. Small lots of ore were shipped from the A. B. C. and Rosebud mines.

*Pioneer district (Rico).*—An increased tonnage was mined in the Pioneer district in 1911. The ore was either lead or lead-zinc, and all was shipped to smelters at Durango, Pueblo, and Salt Lake City. The General Sheridan and Rico-Wellington group were the principal mines. Other producing mines were the Badger, Butler, Humboldt, Lilly D., Newman, Revenue, and Rico Mining Co. group.

### DOUGLAS COUNTY.

There was a small quantity of placer gold recovered by sluicing in Newlins Gulch, near Parker, in Douglas County, in 1911.

---

[1] See Julian, Charles, Gold Dredging in Costilla County, Colo.: Min. Sci., May 25, 1911, pp. 540–542. Also, Patton, Smith, Butler, and Hoskins, Geology of the Grayback mining district, Costilla County, Colo.: Bull. Colorado State Geol. Survey for 1909, No. 2, 1910.

[2] See Parmalee, H. C., Zinc-ore dressing in Colorado: Metall. and Chem. Eng., Oct., 1910, pp. 566–570.

EAGLE COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Eagle County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 1,220.55 | $25,231 | 1,991.12 | $41,160 | + 770.57 | +$15,929 |
| Silver.....do.... | 88,313 | 47,689 | 116,109 | 61,538 | + 27,796 | + 13,849 |
| Copper.....pounds... | 209,551 | 26,613 | 66,608 | 8,326 | −142,943 | − 18,287 |
| Lead.....do.... | 397,409 | 17,486 | 855,889 | 38,515 | +458,480 | + 21,029 |
| Zinc.....do.... | 4,147,945 | 223,989 | 5,097,597 | 290,563 | +949,652 | + 66,574 |
| Total..... | ..... | 341,008 | ..... | 440,102 | ..... | + 99,094 |

The total value of the production of gold, silver, copper, lead, and zinc in Eagle County in 1911 was $440,102, as compared with $341,008 in 1910 and with $202,244 in 1909. There were important increases in the output of all the metals except copper, for which there was a material decrease. The county maintained its place as third in the production of zinc. There were 12 producing mines, 1 of which was a placer, as against 12 deep mines and 1 placer in 1910. There was an appreciable increase in tonnage sent to separating mills, but a decrease in tonnage to smelters.

*Battle Mountain district.*—Lead-zinc ore from the Iron Mask group in the Battle Mountain district was treated in the company's 60-ton magnetic separation mill, yielding a lead and a zinc concentrate. Crude ore, carrying silver, lead, copper, and some gold was also shipped from this mine. Lessees on the Ground Hog mine shipped gold-silver ore, carrying a little copper and lead. Gold-silver ore was shipped from the Ben Butler mine. Ore of similar character was shipped from the Pine Martin group. Lead ore was shipped by lessees from the Bleak House mine. Other mines from which ore was shipped were the Eastern County, Horn Silver, Wyoming Valley, Star of the West, and Warrior's Mask.

*McDonald district.*—A small quantity of gold was recovered by sluicing from the Sunday placer, near McCoy, in McDonald district.

*Girard Mountain district.*—Copper and lead ore was shipped from the California mine in the Girard Mountain district.

FREMONT COUNTY.

Shipments of copper-lead and zinc ores were made from Cotopaxi in Fremont County.

GILPIN COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Gilpin County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 33,277.26 | $687,902 | 37,673.19 | $778,774 | +4,395.93 | +$90,872 |
| Silver.....do.... | 132,635 | 71,623 | 292,659 | 155,109 | + 160,024 | + 83,486 |
| Copper.....pounds.. | 534,244 | 67,849 | 950,240 | 118,780 | + 415,996 | + 50,931 |
| Lead.....do.... | 575,477 | 25,321 | 1,239,356 | 55,771 | + 663,879 | + 30,450 |
| Zinc.....do.... | ..... | ..... | 23,088 | 1,316 | + 23,088 | + 1,316 |
| Total..... | ..... | 852,695 | ..... | 1,109,750 | ..... | +257,055 |

Gilpin County in 1911 produced 103,038 short tons of ore, as against 83,631 tons in 1910 and 111,118 tons in 1909. There were 108 companies or individuals operating deep mines or groups of mines and there were 50 small lots of ore produced from other properties, making a total of 158 mines or groups of mines from which ore was mined, as against 157 in 1910. There was a small yield from 4 placers.

The production of gold in 1911 was $778,774, an increase of $90,872. The output of silver was 292,659 fine ounces, an increase of 160,024 ounces. Copper and lead production made notable increases, and zinc was recovered from Gilpin County ore for the first time.

The tonnage sent to amalgamating mills decreased materially, with a consequent decrease in gold-silver bullion, but the tonnage supplied to mills for concentration only more than doubled and shipments of crude ore direct to smelters increased.

Almost all the ore of Gilpin County falls into the dry siliceous class, there being some ore carrying copper above 2½ per cent and a smalll tonnage of ore carrying lead above 4½ per cent. The average value per ton of siliceous ore in gold and silver was $8.51, of which $7.09 was gold. The average value per ton of Gilpin County ore in 1911 was $10.77, as against $10.19 in 1910.

The Newhouse Tunnel reached in November, 1910, a distance of 21,968 feet, just beyond the Gunnell mine, where work was stopped. Laterals and upraise connections were made with several mines during 1911. The prominent features of mining in Gilpin County were the increased output in Russell district, due principally to the output of the Frontenac mines and the new Frontenac mill, and the increased yield in the Nevada district.

Gilpin County is divided by somewhat indefinite lines into mining districts, having local names which appear to differ with individuals.

*Central district.*—This district, which embraces Central City, made a small but increased production in 1911. Nearly all the ore was milled. Producing mines were the Corydon, Freedom, and Huddleston.

*Enterprise district.*—The total value of the output from this district in 1911 was $2,645. Small tonnages were mined from the Coaley, Cyclops, Little Kingdom, and Mohaska mines. The Clear Creek Mining & Milling Co., in its canvas plant, recovered concentrates carrying gold, silver, and copper from mill waste.

*Eureka district (embracing Gunnell Hill and Eureka and Prosser gulches).*—The Eureka district in 1911 produced 4,778 tons of ore, with a total value of $41,549, as against $26,603 in 1910. The principal metal produced was gold, valued at $35,089, the remainder being chiefly silver and copper about equally divided, and small quantities of lead and zinc. There was an increased tonnage from the Gunnell group, the larger part being milled. Ore from the Eureka mine was milled at the company's 10-stamp mill, the product being gold-silver bullion, lead concentrates, and one lot of zinc concentrates. Other producing mines were the Bon Ton, Buckeye, Concrete, Gold Collar, and Grand Central mines.

*Gregory district (embracing the town of Black Hawk, and the Gregory, Bobtail, and Bates Hills).*—The Gregory district in 1911, from 20 mines, produced 4,909 tons, yielding $20,900 in gold, 9,212 ounces of silver, 28,058 pounds of copper, and 10,950 pounds of lead, with a total value of $29,782, as compared with $82,439 in 1910, with $266,958 in 1909, and with $289,504 in 1908. Usually the second district in

importance in the county, after Russell, this district in 1911 fell behind Nevada, Illinois Central, and Lake districts.

Among the producing mines were the After Supper, Americus, Cicero, Chicago-Carr, Dump Lode, Fifty Gold Mines group, Homer, Iroquois, Klein-German, Maine-Hamlet, Morning Star, O. K., Ontanogan, Running Lode, Senator, U. P. R., and Whitesides.

Desultory work by lessees was all that was done on the Fifty Gold Mines group, and the company's 350-ton mill was idle. The U. P. R. custom mill was operated all the year and the U. P. R. mine was the chief producer in the district in 1911. Operations on the other mines were by lessees.

*Illinois Central district (embracing Illinois and Leavenworth gulches and the east portion of Quartz Hill).*—The Illinois Central district in 1911, from 7 mines, produced 5,340 tons, yielding $49,877 in gold, 10,554 ounces of silver, and 60,475 pounds of copper, with a total value of $63,030, as compared with $44,270 in 1910. The principal producing mine was the Egyptian. Others were the Baxter, East Missouri, Gladstone, Harsh, and Kirk.

*Lake district (Lake Gulch).*—The Lake district produced 2,714 tons, with a total value of $48,249, of which $39,542 was for gold. The New National Tunnel group, the Pittsburg, and the West Notoway were the chief mines in 1911.

*Nevada district (Nevadaville).*—The Nevada district in 1911, from 22 mines, produced 9,564 tons, yielding $93,719 in gold, 14,163 ounces of silver, 83,195 pounds of copper, 56,743 pounds of lead, and 20,580 pounds of zinc, with a total value of $115,350, as compared with $54,273 in 1911, an increase for 1911 of $61,077. For 1911 this district took second rank in the county. Among producing mines were the Alger-Kansas, Barnes, Columbia Tunnel group, Dyke, East and West Flack, Forks, Fourth of July, Hubert, Mitchell, National, Newfoundland, Prize, Ralls County, R. D. Kinney, San Juan, Shanks Tunnel, and West Baker. The Dyke and Prize mines were worked on the Newhouse Tunnel level. Zinc was recovered from the Hubert ore in 1911.

*Quartz Valley district.*—The center of the Quartz Valley district lies 1 mile north of Central City. The total value of the production was $1,023. Producing mines were the Hayseed Tunnel, Margaret Glennon, and Robert Emmett.

*Russell district.*—The Russell district lies southwest of Central City, extends to the Clear Creek County line, and is the most important district in Gilpin County. The total production in 1911 was 70,760 tons of ore, from which were recovered $492,396 in gold, 239,779 ounces of silver, 696,637 pounds of copper, and 1,111,906 pounds of lead, with a total value of $756,595, as compared with $485,948 in 1910 and with $441,871 in 1909. About 9 per cent of the tonnage was sent to amalgamating and concentration plants, and over 70 per cent of the tonnage was sent to mills for concentration only, and concentrates produced carried under one-half of the gold and over one-half of the silver, almost two-thirds of the copper, and 95 per cent of the lead output of the district. The remainder of the ore was sent crude to smelters, this ore carrying 1.067 ounces of gold and 6.52 ounces of silver per ton, 1.04 per cent copper, and some lead. Among mines producing copper in addition to gold and silver were the Anchor, Aurora, Chase, Denbigh, East Notoway, Federal, Gibson,

Gulch, Lotus, Old Town group, Pewabic mines, Rockford, Russell, Saratoga, and Two-Forty. Among mines producing both copper and lead in addition to gold and silver were the Aduddel, Frontenac, Druid, Hampton, Topeka, and War Dance.

*Northern districts.*—The outlying districts in Gilpin County are Vermilion district, 4 miles northwest of Central City; Pine district, 7 miles northwest of Central City; Independence and Union districts, 9 miles north of Central City, embracing Perigo and Rollinsville, Lump Gulch, and Moon Gulch sections; and Phoenix district, along the north edge of the county, near the Boulder County line.

*Independence and Union districts.*—Near Perigo and Rollinsville were the principal mines in the outside districts. There were 2,224 tons from this district sold or treated in 1911, with a total value of $17,541, of which $16,957 was gold. Over 91 per cent of the tonnage was milled. Ore from the Smuggler mine was treated at the company's 10-stamp amalgamation and concentration mill. Ore from the Perigo mines group was treated in the plate-amalgamation and concentration mill on the property and was also shipped crude to smelters. Other producing mines were the Free Gold, Michigan, Providence-Newport, and Star mines.

*Pine (or Wisconsin) district.*—Ore from the London mine, in Twelve Mile Gulch, Pine district, was shipped crude to smelters and also sent to the Iron City mill, Black Hawk.

*Vermilion district.*—A small tonnage of milling and smelting ore was shipped from the Golden Sheaf mine in the Vermilion district.

## GUNNISON COUNTY.[1]

*Mine production of gold, silver, copper, lead, and zinc in Gunnison County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 11,318.40 | $233,972 | 7,016.26 | $145,039 | −4,302.14 | −$88,933 |
| Silver.....do.... | 49,189 | 26,562 | 32,541 | 17,247 | − 16,648 | − 9,315 |
| Copper.....pounds.. | 21,024 | 2,670 | 9,928 | 1,241 | − 11,096 | − 1,429 |
| Lead.....do.... | 581,841 | 25,601 | 631,933 | 28,437 | + 50,092 | + 2,836 |
| Zinc.....do.... | 176,815 | 9,548 | 557,456 | 31,775 | + 380.641 | + 22,227 |
| Total..... | ..... | 298,353 | ..... | 223,739 | ..... | − 74,614 |

Gunnison County in 1911 produced 11,926 tons of ore, with a total value of $223,739, as compared with $298,353 in 1910 and with $167,344 in 1909. Tonnages in 1910 and 1909 were 25,203 tons and 9,071 tons, respectively. Decreases for 1911 were chiefly in gold and silver yields. The zinc production showed a notable increase. The decrease in gold was in the Cochetopa and Gold Brick districts. Lead output increased in Tomichi district and decreased in Gold Brick district, but the Elk Mountain district (with no output in 1910) made a considerable production of this metal in 1911. Zinc was produced in both the Rock Creek and the Tomichi districts.

[1] For a brief account, see Hill, J. M., Notes on the economic geology of southeastern Gunnison County, Colo.: Bull. U. S. Geol. Survey No. 380, 1909, pp. 21–40.

*Box Canyon district* (*Waunita Hot Springs*).—There was no output from the Box Canyon district in 1911.

*Cochetopa district* (*Sillsville*).—Output of bullion and concentrates from the amalgamation and concentration mill on the Maple Leaf mine at Sillsville decreased.

*Elk Mountain district* (*Crested Butte*).—Crude ore to smelters and concentrates from mills were shipped in 1911. Lead ore and concentrates were shipped from the Doctor mine, and lead ore was shipped from the Elk Mountain and Star mines; but from the Empress and Washington mines it was concentrated.

*Gold Brick district* (*Ohio*).—The Gold Brick is the principal producing district in Gunnison County. Nearly all the ore was milled in 1911. There were 3 amalgamating and concentration mills in operation—the Carter, the Gold Links, and the Raymond plants. Several cars of crude ore were shipped direct to smelters from the Gold Links and Grand Prize mines. The value of the ore in this district is chiefly in gold, the other metals contained being lead, silver, and copper, in order named.

*Quartz Creek district* (*Pitkin*).—A small tonnage of gold-silver ore was shipped from the Ben Franklin mine in the Quartz Creek district.

*Rock Creek district* (*Marble*).—Several cars of zinc ore were shipped to Canyon City from the Lead King mine of the Rock Creek district.

*Tin Cup district.*—A small shipment of lead ore was made from the Olyniana mine of the Tin Cup district. An appreciable quantity of placer gold was recovered in this district by hydraulicking.

*Tomichi district* (*Whitepine*).—An increased tonnage of lead-zinc ore was shipped from the Morning Star mine in the Tomichi district.

## HINSDALE COUNTY.[1]

Hinsdale County in 1911, from 6 mines, produced 723 tons of ore, yielding $3,830 in gold, 7,753 ounces of silver, 21,696 pounds of copper, 118,645 pounds of lead, and 36,439 pounds of zinc, with a total value of $18,067, against $107,855 in 1910 and $144,433 in 1909.

*Galena district.*—Most of the producing mines in Hinsdale County are in the Galena district. The Frank Hough mine, which has been the principal producer in the county, was practically idle in 1911. Ore from the Highland Chief mine was milled at the Hanna concentration mill. Crude ore was shipped to smelters from the Emerald Isle, Fanny Fern, and Golden Wonder mines.

*Lake district.*—A car of copper-lead ore was shipped from the Belle of the West mine in the Lake district.

[1] See Irving, J. D., and Bancroft, H., Geology and ore deposits near Lake City, Colo.: Bull. U. S. Geol. Survey No. 478, 1911.

## LAKE COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Lake County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 58,685.36 | $1,213,134 | 54,830.26 | $1,133,442 | − 3,885.10 | − $79,692 |
| Silver.....do.... | 3,322,015 | 1,793,888 | 3,007,296 | 1,593,867 | − 314,719 | − 200,021 |
| Copper.....pounds.. | 3,645,157 | 462,935 | 4,017,504 | 502,188 | + 372,347 | + 39,253 |
| Lead.....do.... | 19,249,503 | 846,978 | 18,499,089 | 832,459 | − 750,414 | − 14,519 |
| Zinc.....do.... | 56,367,445 | 3,043,842 | 71,610,456 | 4,081,796 | +15,243,011 | +1,037,954 |
| Total..... | ..... | 7,360,777 | ..... | 8,143,752 | ..... | + 782,975 |

In 1911, Lake County again ranked second to Teller County in value of production; in tonnage, Teller was first, Lake County second, and San Miguel County third. The Lake County tonnage was 18 per cent and the value 25 per cent of the respective State totals. This county was again first in the production of silver, copper, lead, and zinc, and in the production of gold it followed after Teller, San Miguel, and Ouray counties.

Of the State output, Lake County produced 41 per cent of the silver, 26.5 per cent of the lead, 50 per cent of the copper, and 76 per cent of the zinc.

In 1911, from 94 deep mines, there were sold or treated 438,419 short tons of ore, as compared with 104 producing properties and 462,033 tons in 1910, and with 417,297 tons in 1909. The average gross value per ton of the ore was $18.58 in 1911, as against $15.92 in 1910 and $16.49 in 1909.

Lake County includes the Leadville, St. Kevins or Sugar Loaf, and Twin Lakes districts.

*Leadville district.*—Of a total of 438,419 tons of ore mined in the county, 435,872 tons were from the Leadville district. This district tonnage yielded $1,121,345 in gold, 2,859,069 fine ounces of silver, 4,017,245 pounds of copper, 18,435,513 pounds of lead, and 71,603,842 pounds of zinc, with a total value of $8,049,825, out of a county output of $8,143,752. As compared with 1910, this output showed a decrease in tonnage and a decrease for all the metals except copper and zinc, but an increase in value of $795,603. The output of zinc carbonate ore (which ore was first discovered in 1910) increased from 8,059 tons in 1910 to 83,905 tons in 1911, but production of zinc sulphide ore decreased from 163,218 tons to 79,376 tons. The zinc carbonate ore averaged 31.05 per cent zinc in the crude, and the zinc sulphide averaged 23.29 per cent. As the zinc carbonate ore goes direct to smelters with a higher recovery than that from zinc sulphides, and as most of the zinc sulphide also must be concentrated before smelting, suffering a loss in content in both operations, the recovered metal for 1911 showed a heavy increase, despite a decrease in tonnage of combined zinc ores, from 171,277 tons to 163,281 tons. The tonnage output of iron sulphide ore remained practically stationary; the tonnages of lead and iron-manganese oxide ores decreased; but the output of siliceous ores increased somewhat. The tonnage sent to concentrating mills was less than one-half that in 1910, and tonnages to lead smelters decreased, while tonnages to zinc smelters increased.

*Classification of Leadville ores.*

| Character. | Quantity. | Quantity. | Percentage. |
|---|---|---|---|
| Sulphide: | *Short tons.* | *Short tons.* | |
| Zinc-iron-lead (zinc blende; pyrite with a little galena) | 79,376 | 79,376 | 18 |
| Iron (pyrite with a little copper, gold, silver, and lead) | 147,535 | 169,167 | 39 |
| Iron (pyrite with a little copper, gold, silver, and over 4½ per cent lead) | 21,632 | | |
| Total sulphide | 248,543 | 248,543 | 57 |
| Oxide: | | | |
| Lead | 13,123 | 14,338 | 3 |
| Copper | 1,215 | | |
| Iron-manganese (silver) | 64,296 | 64,296 | 15 |
| Zinc carbonate and silicate | 83,905 | 83,905 | 19 |
| Total oxide | 162,539 | 162,539 | 37 |
| Siliceous (oxide [a]): | | | |
| Gold-silver | 24,790 | 24,790 | 6 |
| Grand total | 435,872 | 435,872 | 100 |

| Character. | Tonnage. | Recovered contents. | | | | | Average. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Gold. | Silver. | Copper. | Lead. | Zinc. | Gold. | Silver. | Copper. | Lead. | Zinc. |
| Sulphide: | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | *Ozs. per ton.* | *Ozs. per ton.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Zinc-iron-lead | 79,376 | (b) | (b) | (b) | (b) | (c) | | d4.30 | | d7.34 | d23.29 |
| Iron pyrite | 147,535 | 32,933.55 | 1,970,054 | 3,587,982 | 1,849,998 | | 0.22 | 13.35 | 1.22 | .63 | |
| Lead | 21,632 | 2,534.95 | 192,085 | 92,941 | 3,481,518 | | .11 | 8.88 | .21 | 8.05 | |
| Oxide: | | | | | | | | | | | |
| Lead | 13,123 | 4,317.97 | 85,318 | 33,632 | 1,934,868 | | .33 | 6.50 | .13 | 7.37 | |
| Copper | 1,215 | 6.76 | 968 | 190,727 | 417 | | .006 | .80 | 7.85 | | |
| Iron-manganese (silver) | 64,296 | 1,566.16 | 319,574 | | 2,353,112 | | .024 | 4.97 | | 1.83 | |
| Zinc | 83,905 | | | | | (c) | | | | | e31.05 |
| Siliceous | 24,790 | 9,412.50 | 105,620 | 20,648 | 311,938 | | .38 | 4.26 | .42 | .63 | |
| Metallics | | 2,223.13 | 724 | | | | | | | | |
| Total | 435,872 | | | | | | | | | | |

| Character. | Tonnage. | Recovered contents. | | | | |
|---|---|---|---|---|---|---|
| | | Gold. | Silver. | Copper. | Lead. | Zinc. |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Dry and siliceous ores [f] | 214,989 | 42,537.32 | 2,050,847 | 2,671,584 | 2,953,767 | |
| Copper ores [g] | 12,963 | 3,401.58 | 278,184 | 1,110,090 | 64,762 | |
| Lead ores [h] | 44,407 | 6,955.84 | 337,957 | 126,573 | 6,885,447 | |
| Zinc ores [i] | 96,223 | 135.17 | 8,299 | 3,763 | 36,058 | 49,612,673 |
| Copper-lead ores [k] | 232 | 100.28 | 7,355 | 17,683 | 27,875 | |
| Lead-zinc ores [l] | 67,058 | 1,114.87 | 176,427 | 87,552 | 8,467,604 | 21,991,169 |
| Total | 435,872 | 54,245.06 | 2,859,069 | 4,017,245 | 18,435,513 | 71,603,842 |

[a] Nearly all the siliceous ore is also oxide and dry. Pure metallic gold, in quantity 2,223.13 fine ounces, valued at $45,956, came from less than a ton of ore, probably from siliceous oxide ore bodies.
[b] Estimated recovery, as lead and iron concentrates and zinc residues.
[c] Zinc figured as spelter or as zinc in zinc oxide.
[d] Average assay crude ore, mostly milled. (Lead wet assay.)
[e] Average assay crude. All to zinc smelters.
[f] Includes siliceous oxide, largest part of iron-manganese (silver), largest part of iron pyrite. Smelting ores.
[g] Sulphide and oxide. Smelting ores.
[h] Sulphide and oxide lead ores, and that part of iron-manganese ore carrying lead over 4½ per cent. Smelting ores.
[i] Sulphide and carbonate. Greater part to smelters.
[k] Sulphide. Smelting ores.
[l] Sulphide. Greater part to magnetic separating mills.

The course of treatment of Leadville ores, from mine mouth to market, is shown graphically in the following figure:

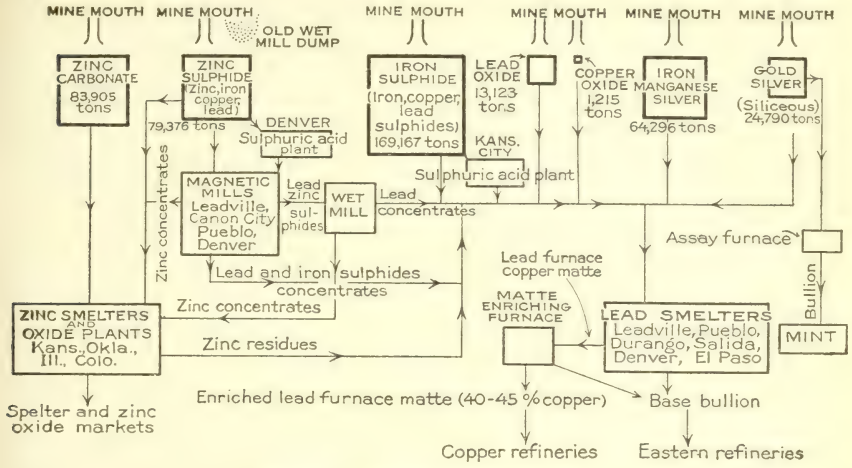



FIGURE 1.—Flow sheet of Leadville ores.

### THE YAK TUNNEL.

The Yak drainage tunnel, starting in California Gulch, has been driven about 4 miles in a general eastward direction toward the amphitheater of Big Evans Gulch and toward the Mosquito Range, and 3 miles or more of laterals have been run. Work in driving the heading was not resumed until November, though development and mining were active during the year.

### MINES REVIEW.

*California Gulch, Iron Hill, Breece Hill mines, as opened by the Yak tunnel.*—The main source of the ore supply from the Yak tunnel was again the Silver Cord vein. A winze has been sunk from the tunnel level 600 feet, 8 levels being turned off, the bottom level being in the Cambrian quartzite. The tunnel level at this point is 600 feet below the surface. The Resurrection No. 1 mine is worked above the tunnel level, the ore being lowered for shipment. Besides the operations of the Yak Co. and its auxiliary companies, there are a number of shipments of ore by lessees from other mines controlled and developed by the Yak Co. Other mines from which ore was shipped in 1911 were the Colonel Sellers, Fraction, Comstock (or Hopemore), Dolly B., Favorite, Fortune, Habendum, Penfield, Rubie, Sedalia, Sentry, Sierra Nevada, South Cord, Vinnie, and White Cap. The bulk of the ore was iron sulphide, which was shipped to lead smelters, some going to El Paso, Tex., and some to a sulphuric plant at Kansas City, the residues being returned to Colorado. The zinc sulphides were treated for part of the year at the magnetic separation mill of the American Zinc Extraction Co., at the mouth of the Yak tunnel, or were sent to the magnetic plant of the Empire Zinc Co. at Canon City, the Western Chemical Co. at Denver, and to Oklahoma smelters. The total shipments averaged about 8,500 tons per month.

*Iron Hill.*—The Iron Silver Mining Co., according to its annual report for the year 1911—

carried on operations continuously, resulting in the production of a tonnage that, while somewhat less than the output of the preceding year, yielded a greater return by reason of the increased per ton value of the ore shipped. The output from the Moyer and Tucson mines was 42,673 tons, of a net value of $10.04 per ton. The Moyer zinc and lead-zinc ores are shipped to the Canon City plant of the Empire Zinc Co., and the Tucson lead-zinc sulphide ores are shipped to the Western Chemical Manufacturing Co. of Denver. Until the closing of the Leadville mill of the American Zinc Extraction Co. some zinc sulphide ore was shipped to that plant. Other ores, including lead sulphide, copper sulphide, iron sulphide, and lead carbonate, were shipped to the American Smelting & Refining Co. Zinc carbonate ores from the Tucson and from lessees' operations went to Oklahoma. Development work amounted to no less than 9,451 feet, the largest amount of work done on the property in any year. * * * Mining operations are being continued into the present year, with a large ore tonnage in reserve. * * * Prospecting in the hitherto unexplored territory adjacent to the South Moyer, south of the Moyer fault, disclosed an ore body parallel to the main shoot of a maximum width of 60 feet and an average thickness of 25 feet, consisting of a mixture of galena, zinc blende, and pyrite, and carrying about 8 ounces silver per ton. * * * To the production of this ore is due the increase in the value of shipments sent out during the last quarter of the year. The upper levels of the Tucson mine were explored for oxidized zinc ores, but no appreciable amounts were disclosed of marketable ores, although a large body of 24 per cent zinc ore was discovered on the first level. Some marketable oxidized lead ores were discovered in the search for zinc ores on the second level. Drifting on the sixth level * * * encountered a deposit of copper in the northwest extension. This ore is contained in the fault and is the downward extension of the ore body previously opened on the level above. The copper ore occurring along the fault under the sixth level yielded the bulk of the copper production. Development work on the bottom level cut the fault between granite walls and further prospecting proved it to be tight and barren. * * * This level is now being carried south to intersect the porphyry dike that carried ore on its contact dipping below the eighth level. The ore contained in the Cambrian quartzite channels above the bottom level has been completely worked out. Prospecting on the Stevens mine found numerous small veins of zinc carbonate * * * too small for profitable working, but prospecting at a lower horizon was begun.[1]

Lead-zinc sulphide ore was shipped to Canon City from the A. Y. and Minnie mine. The Empire Zinc Co., and the U. S. Zinc Co., purchasers of the A. Y. and Minnie tailings dump, again shipped this sulphide zinc ore to Canon City and Pueblo, where it was separated magnetically. This dump, a source of much of the zinc sulphide output in the last few years, is nearly exhausted.

A steel surface plant was placed on the Colonel Sellers mine and iron, lead, zinc, and lead-zinc sulphide ores were shipped in 1911. Iron sulphide was shipped from the Rubie mine. Lead-zinc, zinc, and lead sulphide ore was shipped from the Louisville mine. Iron sulphide and lead oxide ore was shipped from the Adelaide, on North Iron Hill, iron sulphide and siliceous ore from the Benton mine, and lead oxide and sulphide from the Mikado-Camp Bird mines.

*Breece Hill.*—Breece Hill embraces the chief mines of the gold belt.

Lessees on the property of the Ibex Mining Co. continued to ship iron pyrite, copper and lead oxide, lead sulphide, some zinc sulphide, and zinc carbonate ores, as well as considerable metallic gold. A large tonnage of copper-iron sulphide was shipped from the Garbutt mine and iron sulphide ore was shipped from the Maud Hicks and St. Crispen mines adjoining. A large tonnage of iron-manganese oxide and siliceous oxide was shipped from the Breece-Iron mine and siliceous ore was shipped from the Ballard group by the Gold-Bismuth Co. No bismuth was mined in 1911, but some was marketed

[1] Excerpts from annual report of Iron Silver Min. Co.; and from Eng. and Min. Jour., Apr. 6, 1912, p. 700.

in 1912. Siliceous iron oxide from the Big Six; siliceous oxide carrying lead, silver, and gold from the Black Prince; iron sulphide and siliceous oxide from the Humboldt; lead oxide and sulphide from the Fannie Rawlings and Nevada; lead oxide from the St. Louis tunnel; zinc carbonate from the Rattling Jack, and iron sulphide ores from the Vinnie mine were shipped to smelters.

*Ball Mountain.*—On the western lower part of Ball Mountain, north of Breece Hill, high lead sulphide and siliceous oxide ores were shipped from the Bald Mountain and Sunday mines.

*South Evans Gulch—Little Ellen Hill.*—The New Monarch Mining Co. continued to ship large tonnages of sulphide and oxide siliceous ores. The shaft on this property was sunk 100 feet in 1911 to a total depth of 830 feet. Lead oxide and sulphide ores were shipped from the Valley mine, lead oxide ore from the Famous, Little Ellen, and Silver Spoon mines, and lead and iron sulphide ores from the Silent Friend mine. Ores of this district carry appreciable gold and silver content.

*Stray Horse Gulch.*—Siliceous gold-silver ore was shipped from the Double Decker mine.

*Carbonate Hill.*—The bulk of the output of zinc carbonate at Leadville came from mines on Carbonate Hill. Large tonnages were shipped from the Big Chief mine and from the Wolftone, Maid, and other mines of the Western Mining Co., and from the Star Consolidated mines. Lead-zinc sulphide also was shipped from the Wolftone to a Kansas zinc-oxide plant. A large tonnage of iron-manganese-silver fluxing ore was shipped from the Star mines. Iron-manganese ore was also shipped from the Agassiz, Catalpa, Castleview, Evelyn, Shamrock, Modoc, and Yankee Doodle mines. Lead and lead-zinc sulphide were shipped from the Goneabroad and Arabi Boy mines.

*Fryer Hill.*—Lead oxide ore was shipped from the Amie mine, iron-manganese oxide ore from the Climax, Dunkin, Matchless, and Small Hopes mines, and siliceous oxide ore from the Little Sliver and R. E. Lee mines. Considerable zinc carbonate and some iron-manganese ores were shipped from the Chrysolite mine, and iron-manganese, lead oxide, and zinc carbonate ores were shipped from the Little Chief mines.

*Printer Boy Hill.*—Lead oxide ore, zinc-carbonate ore, and some pure gold were shipped from the Lillian group, and siliceous gold-silver ore from the Lovejoy mine.

*Rock Hill.*—Chiefly iron oxide ores were shipped from the La Plata group, New Emmett group, Nisi Prius, and Lecompton mines, on Rock Hill, east of Iron Hill, across California Gulch.

*Iowa Gulch.*—Lead sulphide ore was shipped from the Hellena mine, and lead oxide from the Long and Derry group.

*Downtown district.*—Lead oxide ore was shipped from the Hibschle mine and from the Henriette mine. A considerable tonnage was mined from the Virginius mine.

*St. Kevin—Independence or Sugar Loaf district.*—Along the base of the Sawatch Range, including St. Kevin and Sugar Loaf Mountain, is a mineralized region where considerable development by adits has been done. A car of zinc ore and one of lead ore were shipped from the Carlton-Griffin mine, and a large tonnage of siliceous oxide ore, carrying lead, silver, and gold, was shipped from the Dinero mine. Several cars of gold-silver ore were shipped from the Amity mine by the Gleason Gulch Co., and siliceous ore was shipped from the Fanchon

mine, and oxide and sulphide silver ore by the Sugar Loaf Consolidated Mining Co.

*Twin Lakes district.*—Small shipments were made from the Belle of Granite, Columbine, and Ontario mines. Some gold was recovered from the Mud mine. Much development work was done on the properties of the Miller Mining & Tunnel Co. and of the Mount Champion Mining Co., in Lackawanna Gulch. There is a 30-stamp amalgamating and concentration mill on the former property and a mill is under construction on the latter property.

## LA PLATA COUNTY.

*Mine production of gold, silver, copper, and lead in La Plata County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 18,907.08 | $390,844 | 13,880.58 | $286,937 | −5,026.50 | −$103,907 |
| Silver.....do.... | 141,537 | 76,430 | 69,438 | 36,802 | − 72,099 | − 39,628 |
| Copper.....pounds.. | 142 | 18 | 73,728 | 9,216 | + 73,586 | + 9,198 |
| Lead.....do.... | 273 | 12 | 1,511 | 68 | + 1,238 | + 56 |
| Total..... | ..... | 467,304 | ..... | 333,023 | ..... | − 134,281 |

Owing to litigation between two of the principal mining companies of La Plata County, there was a decrease in the output of both gold and silver in 1911 as compared with the output in 1910. However, the yield was double that for the year 1909. There were 10,058 short tons of ore sold or treated in 1911, as compared with 6,350 tons in 1910 and with 4,135 tons in 1909. Practically all the ore produced in 1910 was shipped direct to smelters, but in 1911 about one-third of the tonnage was milled. The average value per ton of the output was lower than in 1910, being $28.53 for gold and $3.66 for silver in 1911, as compared with $61.55 for gold and $12.04 for silver in 1910.

There were 19 producing deep mines in 1911, as against 8 in 1910.

The majority of the mines are situated on the west slope of the La Plata Mountains, in the drainage basin of La Plata River, near the town of La Plata, 10 miles from Hesperus, the shipping point on the Rio Grande Southern Railroad. The region is sometimes known as the California district. Prospecting for gold and silver was first begun in 1878. The ores are in general of two kinds—telluride ores and gold, either free or associated with pyrite.[1]

The Incas Nos. 1, 2, and 3 mines were the principal producing mines in the district in 1911. A considerable tonnage of ore, carrying a very high content of gold and silver, was shipped from the Valley View group, and a considerable tonnage was also shipped from the May Day mine, but, owing to litigation between these two companies, the yield from both was less than in 1910. Shipments of ore, carrying comparatively high contents of gold and silver, were made from the Bessie G., Blue Dick, Buckwheat, Comstock, Cumberland, Eagle Pass, Gold Coin, Neglected,[2] Lucky Moon, Ten Broeck, Tomahawk, and Yellow

[1] Cross, Whitman, La Plata folio (No. 60), Geol. Atlas U. S., U. S. Geol. Survey, 1899, p. 12.

[2] See Emmons, W. H., The Neglected mine and near-by properties, Durango quadrangle, Colorado: Bull. U. S. Geol. Survey No. 260, 1905, pp. 121–127.

Eye mines. Silver-copper ore was shipped from the Copper Hill, and silver-lead-gold ore from the Volcanic mine. Ore from the Cumberland mine was also treated in the amalgamation and concentration plant on the property. Much development was done in this district in 1911.

On the west slope of the west ridge of the La Plata Mountains, in the same district but in Montezuma County, is the property of the Doyle Consolidated mines, on which property in 1911 was built a 50-ton roaster-cyanide plant. Operation of this plant was started in July, 1912.

### LARIMER COUNTY.

Prospecting and some development work were reported from the Manhattan district, about 45 miles northwest of Fort Collins, and from the district near Elkhorn.

### MESA AND MONTROSE COUNTIES.

The Mesa Mining & Milling Co. reports underground workings of shafts 325 feet and 100 feet, drifts 450 feet, and an adit 750 feet on its properties in the Unaweep district. Copper, gold, and silver in sulphide ores are found. No work was done at the Pyramid property in Sindbad Valley. No work was done at the La Sal mines, near Cashin, which have been opened by a vertical shaft 225 feet deep, by an adit 1,400 feet long, and by 400 feet of drifts. The ores of this region occur as impregnations of the lighter-colored sandstones immediately overlying the "Red Beds." [1]

### MINERAL COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Mineral County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 5,852.13 | $121,181 | 8,668.61 | $179,196 | + 2,806.48 | + $58.015 |
| Silver.....do.... | 773,722 | 417,810 | 545,319 | 289,019 | − 228,403 | − 128,791 |
| Copper.....pounds.. | 29,031 | 3,687 | 33,384 | 4,173 | + 4,353 | + 486 |
| Lead.....do.... | 8,246,000 | 362,824 | 7,674,556 | 345,355 | − 571,444 | − 17,469 |
| Zinc.....do.... | 2,421,926 | 130,784 | 1,258,561 | 71,738 | −1,163,365 | − 59,046 |
| Total..... | ..... | 1,036,286 | ..... | 889,481 | ..... | − 146,805 |

*Creede district.*—All the producing mines of Mineral County are in the Creede district. The output for 1911, as compared with that of 1910, showed an increase in the yield of gold and copper, but heavy decreases in silver, lead, and zinc, and a decrease in value of the county metallic production of $146,805.

There were 65,932 short tons of ore sold or treated in 1911, of which 45,528 tons were milled, and 20,404 tons were sent crude to smelters. The average recovered value of the ore mined in 1911 is represented by the following theoretical assay: Gold, 0.131 ounce, and silver,

[1] Emmons, S. F., The copper in the red beds of the Colorado Plateau region; Bull. U. S. Geol. Survey No. 260, 1905, pp. 227-228.

8.27 ounces per ton; copper, 0.025 per cent; lead, 5.8 per cent; zinc, 1 per cent; an average value for 1911 of $13.49 per ton, as compared with $16.46 in 1910. The assay content of zinc concentrates as shipped was 36.3 per cent.

There were 9 producing mines in 1911. The principal producing mines were the Amethyst and the Creede United mines. The ore from the former is treated in a 100-ton concentration mill, lead and zinc concentrates being shipped. The ore from the latter is treated in the Humphreys concentration mill, with the same general process. The Ridge concentration mill was also operated on ore from the Ridge and Mexico mines. An increased tonnage of smelting ore carrying chiefly lead and silver, with some gold and copper, was shipped from the Last Chance, New York, and Volunteer mines. Similar ore, but with decreased outputs for 1911, was shipped from the Bachelor and the Commodore mines. Other mines from which ore was shipped were the Alpha and the Consul.

### MOFFAT COUNTY.

*Four Mile district (near Baggs, Wyo.).*—Sluicing and hydraulicking recovered a total of $4,942 in placer gold and 21 ounces of silver from bench and river gravels. The Timberlake was the principal mine in the district. Other producing placer mines were the Hawkeye and Buckeye, the Nelson Bar, and the Pole Gulch.

### MONTEZUMA COUNTY.

The mines in Montezuma County are situated at the head of East Mancos River, on the west slope of the west ridge of the La Plata Mountains, this ridge being the arbitrary dividing line between La Plata and Montezuma counties. This district is part of the California or La Plata district of La Plata County.

### OURAY COUNTY.

*Mine production of gold, silver, copper, and lead in Ouray County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 106,224.10 | $2,195,847 | 94,474.34 | $1,952,958 | −11,749.76 | − $242,889 |
| Silver.....do.... | 414.250 | 223.695 | 512,800 | 271,784 | + 98,550 | + 48.089 |
| Copper.....pounds.. | 620,236 | 78,770 | 564,273 | 70,534 | − 55,963 | − 8,236 |
| Lead.....do.... | 4,004,728 | 176,208 | 3,949,822 | 177,742 | − 54,906 | + 1,534 |
| Total..... | ..... | 2,674,520 | ..... | 2,473,018 | ..... | − 201,502 |

Ouray, one of the "San Juan" counties, was one of four counties in the State making a production of over $2,000,000, and ranked third in the production of gold and fourth in the value of total metallic production. The yield of gold in 1911 was $1,952,958, a decrease as compared with that of 1910 of $242,889. The output of silver increased, but the quantity of copper and lead decreased somewhat, although the value of the lead showed a small increase.

The tonnage of ore sold or treated in 1911 was 133,252 short tons, against 111,245 tons in 1910 and 103,864 tons in 1909. There were 31 productive mines in 1911 and 24 in 1910. The average value per ton in 1911 was $18.56, against $24.04 in 1910, $33.45 in 1909, $25.43 in 1908, and $30.18 in 1907. The average value per ton in gold was $14.66, against $19.74 in 1910, $29.32 in 1909, and $21.02 in 1908.

The tonnage of siliceous or dry ores sold or treated increased from 107,260 tons in 1910 to 130,624 tons in 1911. The tonnage of copper, lead, and copper-lead ores combined decreased 1,357 tons.

In 1911, of the 133,252 tons mined, 102,376 tons were treated at amalgamating and cyaniding mills having concentration equipment, and an average of $12.60 per ton in gold and $0.21 in silver was recovered as bullion. From this ore sent to amalgamation and cyanide mills, and from 26,682 tons sent to mills for concentration only, were produced 17,387 tons of concentrates, averaging $35.97 in gold, $8.96 in silver, $3.70 in copper, and $7.70 in lead, a total of $56.33 per ton. Those concentrates which carried copper averaged 1.70 per cent of copper, and those which carried lead averaged 12 per cent of lead. Milling ore averaged $15 in gold and $1.37 in silver per ton. Crude ore shipped to smelters averaged $9.03 in gold, $22.58 in silver, $1.46 in copper, and $10.48 in lead, a total average value of $43.55 per ton. Crude ore which carried lead averaged 4.82 per cent of lead.

*Paquin district.*—There was a slight increase of tonnage (all smelting ore) from the Paquin district in 1911, but the contents (chiefly silver) were less than in 1910, with a consequent decreased total value. As in 1910, the Neodesha and the Wedge were the principal producing mines. Small shipments were made from the Indiana and the Midnight mines.

*Red Mountain district.*—The tonnage mined in the Red Mountain district in 1911 was more than twice that in 1910, but all the ore was smelted in 1910, whereas in 1911 the greater part was milled, the ore being of lower average grade in 1911. The district in 1911 produced 7,970 tons, yielding $33,836 in gold, 46,763 ounces of silver, 44,817 pounds of copper, and 655,807 pounds of lead, valued at $93,733, as compared with $79,331 in 1910, an increase for the year in total value of $14,402. An appreciable tonnage of ore from the Barstow mines was sent to the company's concentration mill, as well as some direct to smelters. Ore was also shipped from the Mono-Baltic, Oom Paul Kruger, and Yankee Girl mines.

*Sneffels district.*—The Sneffels is the principal district in Ouray County. In 1911, from 7 mines, there were sold or treated 102,163 tons of ore, from which were recovered $1,782,286 in gold, 363,765 ounces of silver, 389,901 pounds of copper, and 3,075,078 pounds of lead, with a total value of $2,162,198, as compared with $2,493,165 in 1910. There was a slight decrease in tonnage sold or treated, but the gold content decreased $367,944, and copper and lead content also decreased, but the silver content increased appreciably.

The output from the Camp Bird mine in 1911, as compared with that in 1910, decreased somewhat; there was a material decrease in the gold-silver bullion, with a proportionately decreased tonnage of concentrates produced, which carried a decreased quantity of gold, copper, and lead, but more silver. The mine was active during the entire year, and 60 stamps of the 70-stamp mill were operated. There were 4,633 feet of development work done. The published report

for the fiscal year ended April 30, 1911, shows that the ore reserve stood on April 30 at 38,415 tons, as compared with 83,900 tons the year before, 79,186 tons having been extracted in the meantime and sent to the mill. The yield was $1,685,979 in gold, or $22.89 per ton, $71,435 in silver, $8,408 in copper, and $46,748 in lead, a total of $1,812,571. The recovery of the gold content was just under 95 per cent. Of the total extraction of metals, 64.32 per cent was obtained by amalgamation, 28.81 per cent in the concentrate, and 6.87 per cent by cyanidation.[1] During the quarter from May 1 to July 31, 1911, the mill crushed 18,911 tons, and from August 1 to October 31, 1911, the mill crushed 18,509 tons. During the quarter ended January 31, 1912, the mill crushed 15,760 tons of ore, yielding gross $466,549. About 65 per cent of the ore treated was drawn from reserves in the stopes, and on January 31 the total ore broken in the stopes amounted to 4,017 tons.[2] The annual report says that "the year ending June 1, 1912, would probably see the end of the old Camp Bird"; but the property was being worked in August, 1912.

A greatly increased tonnage was milled at the Atlas mill, with an output in bullion and concentrates, and lessees on the Revenue mine maintained a tonnage equal to that in 1910, the product from this mine being crude ore to smelter and bullion and concentrates from the mill operations. Crude ore to smelters was shipped from the Monument, Mother Kline, Thistledown, and Torpedo-Eclipse mines.

*Uncompahgre district.*—The Uncompahgre district, from 16 mines, in 1911, produced 22,154 tons, yielding $136,749 in gold, 48,049 ounces of silver, 128,421 pounds of copper, and 211,844 pounds of lead, with a total value of $187,802, as compared with $56,230 in 1910, and with $69,922 in 1909. By far the greater part of the ore was treated at mills for concentration only, the rest being amalgamated or sent to smelters.

Copper-lead ore was shipped from the American Nettie mine, lead ore from the Bachelor-Khedive, and lead and dry ore from the Black Girl-El Mahdi mines. Ore from the O. & N. mine was treated in a Huntington mill with plates and 1 Wilfley table. The principal producing property was the Bright Diamond-Ironclad-Memphis group, operated by the Wanakah Co. The greater part of the tonnage from this group was milled in the company's 20-stamp concentration mill. Shipments were made from the American Flag, Eclipse-Dexter, Johnathan, Morning Star, Portland, Rose, Senorita, and Uncle Sam mines.

## PARK COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Park County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 12,845.84 | $265,547 | 2,846.00 | $58,832 | − 9,999.84 | −$206,715 |
| Silver.....do.... | 117,037 | 63,200 | 69,072 | 36,608 | − 47,965 | − 26,592 |
| Copper.....pounds.. | 88,748 | 11,271 | 24,216 | 3,027 | − 64,532 | − 8,244 |
| Lead.....do.... | 2,041,204 | 89,813 | 923,089 | 41,539 | −1,118,115 | − 48,274 |
| Zinc.....do.... | 659,796 | 35,629 | 407,772 | 23,243 | − 252,024 | − 12,386 |
| Total..... | ..... | 465,460 | ..... | 163,249 | ..... | − 302,211 |

[1] Min. and Sci. Press, Dec. 9, 1911, p. 761.

[2] Eng. and Min. Jour., Mar. 30, 1912, p. 666.

The value of the metallic output of Park County in 1911 was $163,249, as compared with $465,460 in 1910, and with $729,079 in 1909. In 1911 the ore sold or treated, practically all shipped crude to smelters, was 5,780 tons, a decrease of 6,549 tons. There were 22 producing deep mines and 3 placers in 1911, as against 13 deep and 4 placer mines in 1910. The placer yield in 1911 was almost twice that of 1910. The average value per ton of all the ore was $24.02.

*Beaver district.*—An appreciable quantity of gold was recovered from the Rhodus placer in Beaver district by sluicing.

*Buckskin district.*—The Buckskin district in 1911 produced 220 tons, which yielded $2,356 in gold, 396 ounces of silver, and 202 pounds of copper, valued at $2,591, as against $2,783 in 1910, $9,680 in 1909, and $34,098 in 1908. Crude ore from the Paris mine was shipped to the smelter, and some was treated on the ground in a 20-stamp mill. Small shipments were made from the Kentucky Belle, Weber, and Wyandotte mines.

*Consolidated Montgomery district.*—The Consolidated Montgomery district in 1911 produced 729 tons, which yielded $8,949 in gold, 5,023 ounces of silver, and some lead and copper, valued at $11,754, as against $34,536 in 1910. Shipments were made from the Dolly Varden, D. H. Hill, Morning Star, Pacific, and Yellow Type mines.

*Freshwater district (Guffey).*—Production was made from the Freshwater district for the first time. Some copper oxide ore being shipped to Omaha by the Mill Gulch Mining Co. The property is opened by a 225-foot vertical shaft and crosscuts at every 50 feet.

*Hall's district.*—Small shipments were made from the Revenue mine in Hall's district.

*Horseshoe district.*—A decreased tonnage of lead and zinc ore was shipped from the Chance-Hilltop mine. A shipment of lead ore was made from the Dauntless mine. The Platte River Placer Co., operating the Snowstorm placers, made an increased yield.

*Mosquito district.*—There was a heavy decrease in the output of the Mosquito district in 1911, for many years the principal district in Park County, the output in 1909 representing 75 per cent of the county yield and in 1910 representing 52 per cent; in 1911 this district represented only 17 per cent of the total value of the county yield.

A comparatively small tonnage was shipped from the London mine, at the head of Mosquito Creek, on the ridge between Leadville and Alma. The ore from this mine in 1911 was lead, carrying a high content of gold, as well as some silver and copper. Ore carrying gold, silver, lead, and some copper, was shipped from the Gold Fern mine. Shipments were also made from the James G. Blaine, Kennebec, and Wheeler mines.

*Sacramento district.*—There was no output in the Sacramento district in 1911.

*Tarryall district.*—There was a small yield from the Silver Heels and the Yellowstone mines in the Tarryall district.

PITKIN COUNTY.

*Mine production of gold, silver, copper, and lead in Pitkin County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 31.25 | $646 | 26.22 | $542 | − 5.03 | − $104 |
| Silver.....do... | 477,813 | 258,019 | 450,772 | 238,909 | − 27,041 | − 19,110 |
| Copper.....pounds.. | 24,843 | 3,155 | 7,408 | 926 | − 17,435 | − 2,229 |
| Lead.....do... | 13,408,250 | 589,963 | 11,084,334 | 498,795 | −2,323,916 | − 91,168 |
| Total..... | ..... | 851,783 | ..... | 739,172 | ..... | −112,611 |

The production of both lead and silver in Pitkin County in 1911 decreased, with decrease also in the yield of the two less important metals of the county—gold and copper. The ore sold or treated in 1911 amounted to 88,823 short tons, against 89,037 tons in 1910 and 112,448 tons in 1909. The tonnage concentrated was larger than in 1910, but the tonnage sent crude to smelters decreased considerably.

Pitkin County maintained its place as fifth in rank in the production of silver, and was second to Lake County in the production of lead.

Ore carrying over 4.5 per cent lead carried 291,636 ounces of silver, and ore carrying lead under 4.5 per cent carried 149,681 ounces of silver. Lead-zinc ore carried 9,455 ounces of silver. The average content of all the ore sold or treated was 5.07 ounces of silver per ton and 6.24 per cent of lead.

*Roaring Fork (Aspen) district.*—The Aspen district furnishes the bulk of the tonnage from Pitkin County. From the Smuggler mine there was a decreased tonnage mined, the proportion of milling ore to smelting ore showing a considerable increase. Smelting ore was shipped from the Argentum-Juniata, Aspen, Durant, Millince, Mineral Farm, and Spar group mines.

*Ashcroft (or Columbia) district.*—An increased tonnage from the Tam O'Shanter-Montezuma mine was treated in the 100-ton concentration plant on the property, lead concentrates being shipped and zinc middlings being held for re-treatment.

*Lincoln district.*—In Lincoln district, in the southeast corner of the county, a shipment of silver ore, carrying lead and a little gold, was made from the Ruby mine.

ROUTT COUNTY.

*Hahns Peak district.*[1]—Sluicing operations on the Blackburn placer produced an appreciable quantity of gold.

Much development was done on the Royal Flush deep mine.

*Slater district.*—Development work was done on the mines near Slater.

SAGUACHE COUNTY.

From 8 mines in Saguache County in 1911 there were produced 184 tons of smelting ore, with a total value for the five metals of $9,616, as compared with $11,407 in 1910. There were decreases in the out-

[1] See George, R. D., and Crawford, R. D., The Hahns Peak region, Routt County, Colo.: First Rept. Colorado Geol. Survey, for 1908, 1909, pp. 189–229.

put of all the metals except zinc, which was produced in this county for the first time.

*Crystal Hill district* (*Del Norte*).—A small shipment was made from the Crystal Hill district in 1911.

*Embargo district.*—A small shipment of lead ore was made from the Comet mine.

*Kerber Creek district* (*Bonanza*).—Lead ores were shipped from the Antoro mines and the Saguache Mining Co.'s mines. Lead-zinc and lead ores were shipped from the Yellow Type mine. Copper-lead ore, from the Elizabeth mine, and copper and dry ores from the Shawmut mine, were shipped to smelters. Active development was done on the Rawley mine, developing ores carrying lead, zinc, copper, silver, and gold. There is an 80-ton concentration mill on this property.

## SAN JUAN COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in San Juan County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 34,371.74 | $710,527 | 16,276.40 | $336,463 | −18,095.34 | −$374,064 |
| Silver.....do.... | 782,250 | 422,415 | 325,604 | 172,570 | − 456,646 | − 249,845 |
| Copper.....pounds.. | 1,208,496 | 153,479 | 470,912 | 58,864 | − 737,584 | − 94,615 |
| Lead.....do.... | 10,688,386 | 470,289 | 6,933,822 | 312,022 | −3,754,564 | − 158,267 |
| Zinc.....do.... | 3,781,259 | 204,188 | 2,224,351 | 126,788 | −1,556,908 | − 77,400 |
| Total..... | ..... | 1,960,898 | ..... | 1,006,707 | ..... | − 954,191 |

The yield of each of the five metals in San Juan County in 1911 showed material decrease, the decrease in total value being $954,191.

There were 37 producing mines in 1911, as against 53 in 1910. The output from deep mines was 108,088 short tons, as compared with 206,272 tons in 1910, a decrease for 1911 of 98,184 tons.

The siliceous-ore output was 82,333 tons, as compared with 178,565 tons in 1910. The copper-ore production decreased from 157 tons to 23 tons, the lead ore increased from 2,436 tons to 13,130 tons, and the copper-lead ores decreased from 1,999 tons to 662 tons. Ores mainly valuable for lead and zinc contents amounted to 11,568 tons in 1911, as against 23,115 tons in 1910. There were also 372 tons of zinc ore produced in 1911. The bulk of the zinc yield came from concentrates from ore chiefly valuable for its gold and silver content.

The average metal value per ton of siliceous ore was $7.82, of which $3.33 was gold; of copper ores, $44.96, of which $3.39 was gold; of lead ores, $16.83, of which $4.29 was gold; of zinc ores, $6.68, of which $0.11 was gold; of copper-lead ores, $74.12, of which $2.12 was gold; and of lead-zinc ores, $7.69, of which $0.37 was gold.

During 1911 there were treated at amalgamation and cyanide mills 62,473 tons, with an average recovery per ton in bullion of $1.90 in gold and $0.02 in silver. There were also 43,696 tons of ore sent to mills for concentration only, a total of 106,169 tons milled (98.2 per cent of all the ore mined) yielding 17,916 tons of concentrates averaging $11.03 per ton in gold, $6.06 in silver, $2.82 in copper, $16.52 in lead, and $7.08 in zinc, with a total gross value per ton of $43.51, as compared with $39.47 in 1910.

The milling ore averaged in value of recovered metals $2.98 per ton in gold, $1.03 in silver, and $4.46 in copper, lead, and zinc, a total of $8.47, as against $7.91 in 1910. Crude ore shipped to smelter—1,919 tons—averaged per ton $10.29 in gold, $32.72 in silver, and $12.66 in copper and lead, a total of $55.67 per ton, as compared with $62.32 per ton in 1910.

The value in 1911 in gold, silver, copper, lead, and zinc of the entire tonnage averaged $9.31 per ton, of which $3.11 was for gold, $1.60 for silver, $0.54 for copper, $2.89 for lead, and $1.17 for zinc.

*Animas district (including the mines in the immediate vicinity of Silverton, and south and east of Animas River from Silverton to Middleton).*—There were 25 producing mines in the Animas district in 1911, as compared with 37 in 1910. The Iowa-Gold Tiger group was the largest producer in 1911, the bulk of the ore being treated by concentration only. The second largest tonnage was from the Silver Lake mines, the bulk of this tonnage also being concentrated. A greatly decreased tonnage from the Hercules property was treated by amalgamation and concentration. Ore from the Intersection mine was treated by amalgamation and concentration, and ore from the North Star and the Old Green Mountain group mines was treated by concentration only. Lead ore was shipped from the Aspen and Dives mines, and copper-lead ore from the Highland Mary mine. Small shipments were made from the Big Giant, Brooklyn, Buffalo Boy, Champion, Kansas City, Queen City, Shenandoah, Slide, and other mines.

From the district there was sold or treated in 1911 a total of 34,849 tons of ore, from which were recovered $116,408 in gold, 184,736 ounces of silver, 330,175 pounds of copper, 3,032,488 pounds of lead, and 38,214 pounds of zinc, valued at $394,230, as compared with $964,987 in 1910.

*Eureka district (north of Silverton, including Chattanooga, Gladstone, Animas Forks, and Eureka).*—There were 12 producing mines in the Eureka district in 1911, as against 16 in 1910. Nearly all the ore in this district is milled. A large and increased tonnage was milled in the Sunnyside mill, which recovered about 60 per cent of the gold and a small quantity of silver on the amalgamating plates, the remainder being recovered as lead and lead-zinc concentrates. A zinc middling is also made, which was stored in 1911. In 1912 a new zinc plant was built, utilizing the Huff electrostatic machine. Lessees operating the Gold King mine and amalgamation and concentration mill marketed bullion and concentrates. Ore from the Silver Ledge mine, at Chattanooga, chiefly valuable for its lead and zinc contents, was treated by concentration only, the product being lead and lead-zinc concentrates. Ore of similar character, from the Bonanza mine, was also treated by concentration. Small outputs were made from the Esmeralda, Joe and John, Kittimac, Paris, and San Juan Queen mines.

From this district there were sold or treated in 1911 a total of 73,239 tons of ore, from which were recovered $219,826 in gold, 140,862 ounces of silver, 140,737 pounds of copper, 3,901,334 pounds of lead, and 2,186,137 pounds of zinc, valued at $612,245, as compared with $779,016 in 1910.

## SAN MIGUEL COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in San Miguel County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 120,685.61 | $2,494,793 | 118,414.31 | $2,447,841 | − 2,271.30 | −$46,952 |
| Silver.....do.... | 1,144,050 | 617,787 | 1,000,834 | 530,442 | − 143,216 | − 87,345 |
| Copper.....pounds.. | 544,189 | 69,112 | 971,064 | 121,383 | + 426,875 | + 52,271 |
| Lead.....do.... | 7,791,841 | 342,841 | 6,456,333 | 290,535 | −1,335,508 | − 52,306 |
| Zinc.....do.... | 2,193,981 | 118,475 | 3,386,088 | 193,007 | +1,192,107 | + 74,532 |
| Total..... | ..... | 3,643,008 | ..... | 3,583,208 | ..... | − 59,800 |

The value of the metallic production of San Miguel County in 1911 was $3,583,208, a decrease, as compared with the yield in 1910, of $59,800, but an increase, as compared with the output of 1909, of $278,120. The Upper San Miguel district showed a small increase in total value of output in 1911, but the Iron Springs and Lower San Miguel districts showed decreases.

The output from 28 mines was 429,354 tons of ore, as compared with 481,000 tons from 43 mines in 1910. The average value per ton in 1911 was $8.35, as compared with $7.57 in 1910, with $7.80 in 1909, with $8.08 in 1908, with $9.08 in 1907, with $10.31 in 1906, and with $9.58 in 1905. In 1911 the average content per ton in gold was $5.70 and 2.33 ounces of silver, as compared with $5.19 in gold and 2.38 ounces of silver in 1910.

The siliceous ore produced amounted to 428,043 tons, being 99.7 per cent of the entire output. Practically all the gold and the bulk of the silver came from this class of ore. The output of lead ores was 1,306 tons.

San Miguel County in 1911, in quantity of output, fell slightly behind Lake County, which was second to Teller County. In gold yield, San Miguel County maintained its place as second to Teller, and in silver, held second place after Lake County. In value of metals produced, San Miguel stood third, with Teller first, Lake second, and Ouray fourth.

During 1911 there were treated at amalgamation and cyanide mills 390,568 short tons of ore, or 91 per cent of all the ore mined; an average per ton of $4.83 in gold and $0.43 in silver was saved as bullion. The gold and silver saved as bullion in 1911 represented 69 per cent of the gold and silver produced in the county.

There were 37,438 tons of ore sent to mills for concentration only, a total of 428,006 tons milled (99.7 per cent of all the ore mined), which yielded 25,994 tons of concentrates, averaging $21.62 in gold, $11.94 in silver, $4.59 in copper, $9.94 in lead, and $7.42 in zinc, a total per ton of $55.51, as compared with $49.98 in 1910.

Milling ore averaged $5.71 in gold, $1.12 in silver, and $1.34 in copper, lead, and zinc, a total of $8.17 per ton, as compared with $7.46 per ton in 1910.

Crude ore shipped to smelters—1,348 tons—averaged $1.66 in gold, $37.42 in silver, $1.51 in copper, $23.90 in lead, or $64.49 per ton, as compared with $45.63 in 1910.

Crude ore and concentrates combined shipped to smelters averaged $20.63 in gold, $13.20 in silver, and $22.12 in copper, lead, and zinc, or $55.95 per ton, as compared with $49.79 in 1910.

*Upper San Miguel district.*—The output from the Upper San Miguel district in 1911 was 382,858 tons of ore, yielding $2,331,398 in gold, 836,357 ounces of silver, 923,412 pounds of copper, 5,334,067 pounds of lead, and 3,386,088 pounds of zinc, valued at $3,323,133, as compared with $3,301,665 in 1910, with $3,177,648 in 1909, and with $3,209,561 in 1908. Three large companies, the Liberty Bell, the Smuggler Union, and the Tomboy, furnished over 95 per cent of the ore, over 95 per cent of the gold and silver, 78 per cent of the copper, 92 per cent of the lead, and over 96 per cent of the zinc of the total production of the district.

The output from the Argentine mine, of the Tomboy Gold Mines Co. (Ltd.) was not quite so large as in 1910, but the contents recovered were greater for all the metals except lead. The magnetic plant for the removal of the iron from the zinc concentrates from the wet mill was not operated, the zinc concentrates being shipped to Pueblo.

The report of the Tomboy Co. for the year ending June 30, 1911, is almost identical with those of the preceding two years. The ore raised amounted to 116,222 tons, yielding bullion valued at $462,773, and concentrate valued at $350,141, the total value being $781,324.

> The * * * manager * * * reports the ore reserve on June 30, 1911, at 427,000 tons, as compared with 444,600 tons in 1910, and he mentions that almost all the stopes have continued to disclose profitable ore. An important step was taken since the conclusion of the year under review, in July last, when the southern portion of the Revenue Tunnel Co.'s property was acquired for $400,000. This piece of property has only been intermittently worked by the Revenue Co., owing to the natural disadvantage of its being on the other side of the divide to the main portion. Its position is favorable to exploitation by the Tomboy Co. At the present time a line is being built to facilitate the transport of ore to the Tomboy mill.[1]
>
> To prove the mine in depth, the shaft was sunk to the 2,100-foot level. For at least 100 feet at that level, states the report, the vein has maintained its average width and grade. No important changes have been made in the plant and equipment, except certain alterations incident to the gradual increasing of the concentrating plant's capacity.[2]

The Liberty Bell mine and mill were actively operated. The Smuggler Union mines and amalgamation, concentration, and cyanide mills were steadily operated. Experiments in 1911 with the cyanide agitation and filter process resulted in the construction of a new cyanide plant in 1912. Ore from the Black Bear mine was treated by amalgamation and concentration, the product being gold-silver bullion and lead and lead-zinc concentrates. The Japan-Flora concentration mill was operated for several months during 1911, the product being lead and zinc concentrates. An appreciable tonnage from the Junta mine was treated by amalgamation in a Denver quartz mill. An increased tonnage of lead concentrates was the product from the mill of the Lewis mine. Other producing mines were the Ballard, Bear, Cimarron, Contention, Gold King, Kitty Mack, La Junta, Mammoth, and Nellie.

*Iron Springs (Ames and Ophir) district.*—The Iron Springs district in 1911 produced 46,416 short tons of ore, yielding $115,609 in gold, 164,381 ounces of silver, 47,652 pounds of copper, and 1,122,266

[1] Min. Mag. (London), December, 1911, p. 475. [2] Min. and Sci. Press, Dec. 30, 1911, p. 853.

pounds of lead, valued at $259,190, as compared with $298,269 in 1910 and with $122,565 in 1909. There was a decrease in the yield of all the metals, except silver.

There were 9 producing mines as against 17 in 1910. An increased output from the Alta mines was treated by concentration, the product being lead concentrates, carrying appreciable quantities of gold and silver, and some copper. The output from the Butterfly-Terrible mines sent to the company's amalgamation and concentration mill also increased. Increased shipments of lead ore were made from the Carbonero group. Lessees on the Carribeau mine shipped an increased quantity of ore to the company's concentration plant. The Favorite mine was operated for two months only in 1911, resulting in a decreased output, sent to a custom amalgamation and concentration mill. A small tonnage was treated in the Lake Superior-Ophir amalgamation and concentration mill. Lead ore was shipped from the San Bernardo group. The Suffolk mill was operated for a short time. Experimental tests with the cyanide process on ores from the Suffolk group in 1911 resulted in the introduction in 1912 of the process, including sliming and agitation and continuous decantation.

*Lower San Miguel (Sawpit and Placerville) district.*—A small quantity of gold-silver bullion was marketed from the treatment of ore from the Golden Rose mine.

## SUMMIT COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Summit County, Colo., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 17,839.05 | $368,766 | 13,750.16 | $284,241 | − 4,088.89 | −$84,525 |
| Silver.....do.... | 152,250 | 82,215 | 182,957 | 96,967 | + 30,707 | + 14,752 |
| Copper.....pounds.. | 21,740 | 2,761 | 22,888 | 2,861 | + 1,148 | + 100 |
| Lead.....do.... | 5,015,409 | 220,678 | 6,024,867 | 271,119 | +1,009,458 | + 50,441 |
| Zinc.....do.... | 5,542,685 | 299,305 | 7,675,175 | 437,485 | +2,132,490 | +138,180 |
| Total..... | ..... | 973,725 | ..... | 1,092,673 | ..... | +118,948 |

Summit County is the foremost placer area in Colorado, and in 1911, as in 1910, 1909, and 1908, the production of zinc was second to that of Lake County. There was a decrease in the production of gold in 1911 from placers, and an increase from deep mines, and there was an increased yield of zinc.

There were 35 producing deep mines in 1911, as compared with 20 in 1910, and the ore sold or treated was 55,904 tons, as compared with 47,040 tons in 1910. There were 9 placer mines, 1 operated by drifting and hydraulicking, 2 by hydraulicking, and 3 by sluicing; and there were 3 operating dredges.

There was in increase in the output of gold in 1911, from deep mines, of $5,257, and a decrease from placer mines of $89,782, making a total decrease in gold of $84,525. The output of silver from deep mines increased 31,832 ounces, while that from placer mines decreased

1,125 ounces. The silver from deep mines was from lead-zinc, siliceous, and lead ores, there being no silver reported from zinc ores in 1911.

*Breckenridge district.*[1]—Breckenridge district includes Bevan, Minnesota, and Union districts; includes the mines near Breckenridge, on French Gulch and on Blue and Swan rivers; and includes all the placers of the county. The value of the total output of gold, silver, copper, lead, and zinc was $865,131, or 79 per cent of the county yield, and an increase for 1911 of $109,775 as compared with the yield in 1910.

The principal producing property in this district is the Wellington mines. A large and increased output of lead-zinc ore was milled at the company's 100-ton wet concentration mill, lead and zinc concentrates being shipped and a zinc middling stored for future treatment by magnetic separation. The roasting and magnetic separator plant, under construction in 1911, was completed early in 1912.[2] Shipments of ore, carrying lead, silver, and gold, were made from the Arctic, Bolivar, Dunkin, Gold Bell, Junebug, Lucky, Ohio, Puzzle, and Standard mines. An appreciable quantity of free gold was marketed from the Boss and Wire Patch mines.

There were operated only 3 of the 4 dredges[3] in the district in 1911. The yield from each was less than in 1910. The Reliance dredge, in French Gulch, is of the double-lift, open-connected type, with buckets of a capacity of 9 cubic feet. The French Gulch Dredging Co., or Reiling dredge, is of the Bucyrus type. Only one of the 2 dredges of the Colorado Gold Dredging Co. was operated in 1911. Both of these dredges are of the Bucyrus open-connected type, with buckets of a capacity of 9½ cubic feet. All the dredges are operated by electricity. The Peabody and the Washington placers were operated by hydraulicking. The Snyder placer was operated by drifting and hydraulicking. Several placers were operated by sluicing, for short periods, with a very small yield.

*Consolidated Ten Mile district (Frisco, Kokomo, and Robinson).*—The yield from 11 mines in 1911 was valued at $168,800, as compared with $184,530 in 1910. All five metals are produced in this district, and each metal showed a decrease for the year 1911. The International (or Robinson) mine was the principal producer. A decrease tonnage from this mine was treated at the Robinson roasting, magnetic separator, and wet concentration mill[4] by the Wilson Mining Co. Small shipments, chiefly of lead ore, were made from the Excelsior, King Solomon, Mary V., and Unexpected mines, near Frisco. From Kokomo, shipments of zinc and dry ore were made by the Kokomo Metals Co. Shipments of dry iron ore were also made from the Mayflower, Michigan, Pearl, Queen of the West, and Wintergreen mines.

*Montezuma*[5] *district.*—An increased tonnage from the Pennsylvania mine was milled in the concentration plant of the New Penn

[1] See Ransome, F. L., Geology and ore deposits of the Breckenridge district, Colorado: Prof. Paper U. S. Geol. Survey No. 75, 1911.

[2] For description of magnetic plant, see Parmalee, H. C., Zinc ore dressing in Colorado: Metall. and Chem. Eng., September, 1911.

[3] See Lakes, Arthur, jr., Gold-dredging operations in Breckenridge district: Min. and Eng. World, Dec. 2, 1911, pp. 1103–1107.

[4] See Parmalee, H. C., Zinc ore dressing in Colorado: Metall. and Chem. Eng., February, 1911, pp. 91–95.

[5] See Patten, Horace B., The Montezuma mining district, of Summit County, Colo.: First Report, 1908, Colorado Geol. Survey, 1909, pp. 104–144; also Spurr, Garrey, and Ball, Prof. Paper U. S. Geol. Survey No. 63, 1908, pp. 69, 104.

Co., the output, a lead concentrate, being shipped to Salida. An increased tonnage was treated at the St. John concentration mill lead concentrates being shipped to Salida. Small shipments of lead ore were made from the Clarion, Hunka Dora, and Silver Wave mines.

TELLER COUNTY.

*Production of gold and silver from Teller County, Colo., ores in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 532,233.99 | $11,002,253 | 510,968.34 | $10,562,653 | −21,265.65 | −$439,600 |
| Silver.....do.... | 54,263 | 29,302 | 57,783 | 30,625 | + 3,520 | + 1,323 |
| Total..... | ..... | 11,031,555 | ..... | 10,593,278 | ..... | − 438,277 |

*Cripple Creek district.*—In 1911 there was recovered from ore from the Cripple Creek district by mills and smelters, from crude ore and dump ore, from the treatment of tailings of previous years, of tailings from operations in 1911, from slags, slimes, "clean-ups" of mills, and from stolen bullion and ore, 510,968.34 fine ounces of gold, valued at $10,562,653, a decrease, as compared with the yield in 1910, of $439,600.

From the viewpoint of the mines alone, as reported from 92 properties, 725,886 short tons of material from mine ore and mine dumps were sold or treated, which averaged per ton 0.6848 ounce gold, valued at $14.16 (or $13.70 at $20 per ounce), a total content of 496,371.35 fine ounces, valued at $10,260,906 (or $9,927,427 at $20 per ounce). In 1910 the number of mines was 83 and the average per ton was 0.7644 ounce per ton, or $15.80 (or $15.29 at $20 per ounce); in 1909 there were 83 producing properties, and the average was 0.9593 ounce, or $19.83, and in 1908 there were 96 producing properties and the average per ton was 0.9922 ounce, or $20.51. Subtracting the tonnage and contents of the dump ore and low-grade ore from the Stratton's Independence, the Portland, and the United Gold mines (outputs being given to the public), the remainder of the ore from Cripple Creek averaged per ton 0.9726 ounce gold (or $19.45 at $20 per ounce).

Conditions in the Cripple Creek district were much the same in 1911 as in 1910 and 1909. For many of the mines it was a year of waiting to see the results of the drainage tunnel. From the company reports it is seen that most of the large properties have been benefited, and work was started on the lower levels early in 1912. The Golden Cycle and the Vindicator Cos., after shutting down the pumps, found that their mines were not being drained and electric pumps were installed to unwater the lower levels of the two properties through joint operations. For the year the average assay per ton (not taking into account the large tonnages of low-grade ore treated by the Stratton's Independence and Portland Cos., and the smaller tonnage of low-grade ore from the United Gold mines) was shown to have been 0.9726 ounce gold, as compared with 0.9922 ounce in 1908. The total tonnage, however, in 1908 (not including old tailings treated

at Colorado Springs) was 601,173 tons, as against 472,256 tons (not including old tailings treated at Colorado Springs nor the low-grade ore of the companies mentioned) in 1911. Figures for both years include stolen bullion for which no tonnage has been given.

### THE CRIPPLE CREEK DRAINAGE OR ROOSEVELT TUNNEL.

Although the Roosevelt Tunnel as originally planned was completed early in 1911, having been driven 16,857 feet when work stopped in April, the flow of water through it and the subsidence in the mines were so slow that it was not possible to start development at lower depth. It became apparent that the tunnel must be driven farther. Work was resumed in October, 1911, and on November 11 a large flow of water was struck and the discharge increased to about 12,000 gallons per minute, compared with 5,800 gallons before. The results early in 1912 were: The El Paso mine was dry to tunnel level; the Gold Dollar and the Mary McKinney mines were practically drained to the lowest workings; the Portland mine recovered its 1,500-foot level, and the Independence its 1,000-foot level; the water in the Elkton, Strong, and Granite mines was subsiding steadily; a level was recovered in the Cresson mine. The Vindicator and Golden Cycle mines seemed not to benefit from the increased flow.

### MILLS AT COLORADO CITY.

In 1911, smelters treated only 5 per cent of the tonnage from Cripple Creek, including slightly over 4 per cent of crude ore and a small tonnage of concentrates. Local mills and mills at Colorado City treated therefore over 95 per cent of the original crude tonnage. In addition, a considerable tonnage of tailings from former operations was treated by the Portland and the Colorado mills at Colorado City.

The valley mills adjoining Colorado City are the Golden Cycle, a roast-cyanide plant of more than 1,000 tons capacity; the two plants of the United States Reduction & Refining Co.; the Standard, a chlorination and concentration plant for crude ore; the Colorado, a cyanide-tailings plant; and the Portland mill, which comprises a 350-ton chlorination and concentration plant for crude ore and a 500-ton cyanide plant for tailings. The Portland chlorination mill was being gradually transformed to a cyanide plant in 1911. Both plants of the United States Reduction & Refining Co. were closed at the end of the year 1911. The tailings of the old Union mill, at Florence, was treated in the new 500-ton cyanide plant, completed early in 1911 by the United States Reduction & Refining Co.

The total output of these mills in bullion was $8,534,832 in 1911, as compared with $8,681,077 in 1910, and with $8,902,459 in 1909.

The report of the Portland Co., in regard to the change from chlorination to cyanide, says:

> The plan adopted is to treat the ore as hitherto until it reaches the hoppers over the chlorination barrels; here the ore will be diverted to tube mills and slimed in cyanide solution, the pulp passing to two 200-ton Merrill filter presses for filtering. These presses are similar to those used at the Homestake mill in South Dakota. * * * The rich gold solution from these presses will be precipitated on zinc dust, which has proven so economical at your Victor plant. The installation of this new plant will not necessitate any additional buildings.

MILLS IN THE CRIPPLE CREEK DISTRICT.

The Stratton's Independence mill, at Victor, started in April, 1909, with a capacity of 4,500 tons per month, was enlarged to treat 7,000 tons in December of that year, and in November, 1910, with the addition of the second unit, reached a capacity of 9,000 tons. The report for the year ending June 30, 1911, shows that the capacity of this concentrating and cyanide plant for treating the dump ore has been brought up to 10,000 tons per month, and that the ore treated during the fiscal year amounted to 109,800 tons, as compared with 68,711 tons the year before. The production was 12,361 ounces of gold, and the recovery 71.5 per cent of the estimated contents—43.65 per cent by concentration, and 27.85 by cyanidation.[1]

The process is as follows: Coarse crushing in Gates gyratory breakers, medium crushing in 36-inch rolls, fine crushing in Chilean mills. Cyanide solution is added in the Chileans, and thenceforward the process is crushing and concentrating in cyanide in a closed circuit. The pulp from the Chilean mills is separated into slime in Ovoca classifiers, the former is treated on 20 Card tables, the latter on 12 No. 3 Deister slime tables, and 4 suspended vanners. A first and second class concentrate is produced, the latter being re-treated on Card and Deister tables, producing more first-grade and a middling product that is returned to a tube mill, and, after grinding, joins the pulp issuing from the Chilean mills and circulates in the main circuit of the mill, finding its position in sand and slime. * * * The slime is worked in charges of about 70 tons, agitated in cyanide solutions of varying strength, and, as required, given a final treatment with bromo-cyanogen.

*Cost of milling.*—The mill reached the 10,000-ton mark in March, 1911, and averaged a little better than 10,000 tons per month for the following three months, closing our fiscal year. The cost for the three months averaged $1.239 per ton.[2]

The Portland Gold Mining Co.'s new concentration and cyanide plant was completed at Victor, in June, 1910. The annual report of the Portland Co. for 1911 says:

Our Victor mill was erected for the express purpose of treating the low-grade telluride ores, without roasting, using cyanide of potassium in connection with the Portland process. * * *

During the past year * * * changes made where necessary brought about an increase in the tonnage capacity of the mill. * * * We were able to treat only 8,052 tons during the month of January, 1911, but in December, 1911, we treated 12,285 tons, of a gross value of $35,432, or an average of $2.80 per ton. Of this amount $28,533.73, or 80.5 per cent, was recovered, the cost of treatment at the mill being $1.1317 per ton. During the entire year there were treated at the mill 120,961 tons of reject, or waste rock, of a gross value of $424,489.15, averaging $3.51 per ton. Of this amount $345,567.98 was recovered, this being an extraction of 81.4 per cent. The net profits of the mill for the year were $128,738.72, this profit being derived solely from what hitherto has been worthless rock.

Other operating mills in the district (all cyanide) were the Isabella, which was operated only a short time; the Jo Dandy (Kavanaugh), a 100-ton cyanide plant, completed and operated during the last few months of the year on the Jo Dandy dump; and the Wild Horse mill, operated the greater part of the year on ore from the Wild Horse group.

The Ajax 200-ton cyanide mill, using the Clancy process, was completed in December, 1911, and was put in operation, but no clean-up was made in 1911.

[1] Min. Mag. (London), December, 1911.

[2] Argall, Philip, Milling methods at Stratton's Independence: Min. Mag. (London), November, 1911, p. 361–370.

MINES REVIEW.

The Acacia Mining Co. property was operated all the year as was the Ajax group, and a small tonnage was shipped from the Amanda mine. The Anchoria-Leland property was continuously operated, a greatly increased tonnage was shipped from the Blue Bird mine, but the Blue Flag mine and cyanide plant were idle. An increased tonnage was shipped from the Christmas mine. The Raaler mine of the C. K. & N. Co., drained by the lateral from the drainage tunnel, was reopened and ore shipped in 1911. An appreciable quantity of ore was shipped from the Commonwealth mine, and a considerably increased shipment was made from school section 16, block 8. Increased shipments were also made from the mines of the Creede & Cripple Creek Co. The shaft on the Cresson Consolidated property was sunk from 1,153 feet to 1,265 feet, and levels were run. The ore house of this property is equipped with trommel screen and washers, and the ore is sorted on a belt, the waste being taken away on a conveyor belt, made of iron slats, thus removing the fines, which go to a bin by another conveyor belt. There was an increased output from this mine. A small output was made from the Cripple Creek Consolidated property. Considerable development in addition to shipping was done on the Dante mine. The Dexter shaft was sunk to the 1,000-foot level, but the tonnage shipped was less than in 1910. The report of the Doctor-Jack Pot Co. shows that the company shipped "4,980 tons of an average assay value of $15.26." Much development work was done. A small tonnage from the Economic mill dump was shipped.

The report of the Elkton Co. for the calendar year 1911, dated February 12, 1912, shows that the company shipped about the same tonnage in 1911 as it did in 1910 and 1909, but—

the grade of ore is lower than in the preceding year by about $4.50 per ton. This is caused by the fact that we were cleaning up a number of low-grade deposits above the ninth level. The ore now being extracted from the tenth will not show any decrease in the average value and does show an increased tonnage from the same vein. We have operated during the year under some disadvantage, being forced to cut a station 55 feet below the ninth level, that being the point where water was encountered. * * * The water at that time was only receding at the rate of three-quarters of an inch per day, and the tunnel was not being advanced toward its present head (it having been closed about six months, from April to October). * * * About October 1, work was resumed, and by December 31 the drainage committee had expended about $20,000 (of $37,500 new fund) with the result that we have a fairly accurate estimate of a drop of 6 inches per day, which is extremely satisfactory to those mining in the district, with the exception of those on the extreme east side, who * * * have not received substantial benefits of the general drainage as yet. * * *

* * * The company trammed 37,195 tons, hoisted 29,565 tons, and shipped 16,951 tons of ore; accordingly there was about 42.67 per cent waste in ore broken. The output for 12 months was 21,026 tons, averaging $16.28 per ton, of which 2,720 tons of mine ore, by lessees, averaged $18.10, and 1,659 tons of dump ore averaged $7.54, and company work shipped 16,504 tons, averaging $16.88, and 173 tons averaging $12.92. The average freight and treatment costs were $5.20, as compared with $5.70 in 1910.

The report of the El Paso Consolidated Gold Mining Co., dated March 6, 1912, shows that—

in the year 1911 the gross ore sales were $681,079. * * * The grand total of development work was 6,466 feet. Practically all the development work on the first, second, third, and fourth levels has been performed by lessees. All the work below the fourth level has been done by the company. * * *

The output from the Ethel Louise mine showed an increase. The annual report of the Findley Co. shows that "the output was 3,597

tons, which netted $19,378." The yield from the Forest Queen mine showed a considerable increase. The Free Coinage property was operated continuously, and the yield was about the same as in 1910; some dump ore was treated at the old Homestake mill, but results did not justify further operations in this direction. The output from the Gold Bond mine, by lessees, showed a decrease. Lessees continued operations on the Gold Dollar group, the output coming chiefly from the Mabel M. mine. Lessees maintained an even yield from the El Paso Gold King mine in Poverty Gulch. Lessees shipped an increased tonnage from the Gold Sovereign mine. The output from the Golden Cycle mines was not equal to the 1910 yield. The Golden Cycle dry concentrator at the mine, for the handling of low-grade ore, is one of the interesting features in the mining and marketing of Cripple Creek ores; much waste rock is necessarily shot down with the ore, and picking belts and Crane washers and other mechanical schemes are used to sort the ore. The description of the Golden Cycle dry concentrator is given in part:

> Owing to the brittleness of the tellurides, crushing tends to separate them from the worthless rock, and they are found with the fine-mesh products. The ore passes over grizzlies to a Blake crusher, which cuts it to about 2-inch product. From the crusher and grizzlies it is fed * * * to 3 revolving screens of 1¾-inch mesh. The oversize goes to rolls. The undersize from the screens and the entire product from the rolls are fed to a revolving screen of 6 mesh. The oversize goes to * * * the dump.[1]

Operations by lessees on the Granite group produced a slightly increased tonnage output but of decreased average content. The Henry Adney mine was operated only two months. Lessees on the Hiawatha mine produced a considerably increased tonnage, and the tonnage from the Index mine also increased considerably.

The report of the Isabella Mines Co. shows "company gross ore sales, $188,094; lessees' gross ore sales, $19,444; mill bullion royalty, $535." Lessees of the mill operated it for a short time on mill tailings.

Lessees and company operations combined on the Jennie Sample mine yielded an increased output for 1911. The report of the Jerry Johnson Co. for the year ending August 31, 1911, shows that "lessees shipped 7,999 tons of ore having a gross value of $136,496." The W. P. H. (or Gaylord) mill on this property was not operated in 1911, and was dismantled in 1912. Ore from the Jo Dandy mine was shipped and the dumps were leased, the Kavanaugh 100-ton cyanide mill being completed during the latter part of the year and operated for a short time on very low-grade material. Small tonnages were mined from the Jolly Tar, Katinka (or Chicken Hawk), and Lady Campbell mines. An increased output was shipped from the Last Dollar mine, and a decreased output from the mines of the Lexington Co. The Maggie mine, adjoining the Cresson, opened by a vertical shaft 300 feet deep, was operated by a lessee, who shipped a considerably increased tonnage in 1911. The Magnet Rock mine was operated by the El Paso Co. A decreased tonnage was mined from the Mary Cashen mine.

According to the annual report—

> the earnings of the Mary McKinney property for the year 1911 were $120,726. The past year has been one of waiting for the water to subside. This desired result has so far progressed that in September we began sinking the main shaft, reaching water at a depth of 95 feet, November 20, when we stopped. After a delay of two weeks, caused

[1] Linderfelt, T. C., and Stewart, J. K., The Golden Cycle concentrator: Min. and Sci. Press, Dec. 9, 1911, p. 741.

by water coming into the shaft, we cut a station * * *. The new level will be * * * 130 feet below the seventh, and 800 feet below the collar of the shaft.

The Michigan and Midget-Bonanza companies shipped ore. The tonnage shipped by the Modoc Co. from the Ocean View mine, according to the annual report, "averaged $44.50, all the ore being shipped to the smelter at Pueblo." Small tonnages were shipped from the Mohican, Mollie Kathleen, New Moon, and Old Gold mines. The Ophir mine was operated by lessees. Only a small yield was made from the Peggy mine. Ore was shipped from the Pharmacist mine.

As shown by the annual report of the Portland Gold Mining Co.—

the gross tonnage shipped to the Colorado Springs mill was 50,258 tons and the gross value $1,140,054, at an average value of $22.68 per ton, as compared with 67,515 tons, at an average value of $18.32 per ton in 1910, with 83,908 tons, at an average per ton of $17.14 in 1909, and with 94,311 tons and an average of $19.45 in 1908. At the Victor mill was treated 120,961 tons, with a gross value of $424,489. The grand total gross value since April 1, 1894, to December 31, 1911, was $32,827,058. The Portland mine is now (Feb. 5, 1912) free from water, due to the success in cutting several water courses by the drainage tunnel, and we are now preparing to conduct general mining operations on the lowest level of the mine, where we have four ore bodies exposed. The tailings from the Victor mill have heretofore been stacked on the surface of your property, but are now being conveyed into the mine and there used to fill old stopes. * * * The large amount of development work accomplished resulted in opening up 20 new stopes and placed more ore in sight than was taken out during the year. The mine maintained its regular monthly shipments to our Colorado Springs mill and also supplied practically all the ore for our Victor mill. * * * During the past month work was started preparatory to developing the ore that has been under water since the pumps were pulled on July 1, 1909. This ore is of better average grade than we have mined and shipped during the past year. * * *

Up to January 1, 1912, the known permanent drainage from the Portland mine by reason of the Deep Drainage tunnel was about 80 feet. The total contributions of the Portland Co. toward defraying the expense of driving the tunnel have been about $60,000. If our property is drained to the tunnel level, which is about 730 feet below the present workings of the mine, the cost for drainage will be less than $100 per vertical foot. When general mining operations were last conducted below the water level, the cost for permanent drainage secured by pumping was $6,500 per vertical foot.

A decreased tonnage was mined from the Pride of Cripple Creek mine, but an increased tonnage was shipped from the Prince Albert mine. The Ruby mine was operated by lessees. Ore was shipped from the Ramona mine. An even yield was maintained from the Requa-Savage mine, and there were small yields from the Rigi group, Rosebud, Rose Maud, Rose Nichol, St. Thomas, Sheriff, and Signal King mines.

The report for the Stratton's Independence mine for the fiscal year ending June 30, 1911, shows—

that in addition to the extraction by concentration and cyanidation of dump ore, 2,752 tons of ore were raised from the mine by the company and 15,633 tons were raised by tributers. It is of interest to note that the caved part of the mine has been reopened by the company and that some high-grade veins have already been disclosed.

The Stratton-Cripple Creek mines, operated by lessees, yielded a large tonnage, but less than in 1910. The Strong mine was operated steadily, but shipments from the Trilby mine were less than in 1910.

From the United Gold mines, according to the annual report—

lessees produced 17,220 tons, averaging $8.26 per ton. The gross value was $142,191. The lessees accomplished 3,076 feet of crosscutting, drifting, and sinking, spending $95,884. There were about 25 sets of lessees mining on different parts of the company's property.

The bulk of the ore from the United Gold mines was treated by cyanidation at the Wild Horse mill.

An increased tonnage was shipped from the Victor mine by lessees.

The Vindicator Consolidated Gold Mining Co., in its annual report, shows—

the production for 1911 from lessees and company work to have totaled 30,223 tons of the assay value of $830,322. During the early part of the year the company completed the installation of a third compartment to its main shaft and has sunk the main shaft to the 1,600-foot level, cutting the 1,500-foot and 1,600-foot stations. During the last six months of the year the company was put to heavy expense in the unwatering of its properties, due to the shutting down of the Golden Cycle pumps. However, * * * a contract covering a period of five years has just been entered into with the Golden Cycle Co., providing for the installation of electric pumps on the main shaft of the Golden Cycle mine and for the unwatering of the properties of the two companies through the joint operation thereof, the expense of such pumping to be equally divided between the two companies. Through this arrangement we expect to have our fourteenth, fifteenth, and sixteenth levels completely unwatered within 60 days. [The superintendent's report shows interesting figures as to ore and waste.] During the year work was done at the main working shaft as follows: 82,160 tons of crude ore were produced, yielding 16,169 net tons of shipping ore of a gross value of $558,176, or $34.50 per ton. At the Hull City shaft work on company account was done as follows: 12,364 tons of crude ore were produced, yielding 3,071 net tons of shipping ore of a gross value of $89,534, or $29.13 per ton. * * * During the year 25,873,000 gallons of water were pumped to the surface. We had no water to pump until August, the Golden Cycle working at a greater depth. * * * On August 2 the Golden Cycle ceased pumping, and the water at once began rising in their workings and appeared in ours. On September 24 the Golden Cycle workings were filled up to our 1,400-foot level, and we received the full flow of 275 gallons per minute, which we pumped until December 6. At this date * * * the closing down of the pumps allowed the water to rise * * * at the rate of 16 to 18 inches per day.

There was an increased output from the Morning Glory mine of the Work Co.

The following table shows the production of the Cripple Creek district from 1891 to 1911, inclusive:

*Production of the Cripple Creek district, Colorado, 1891–1911.*[a]

| Year. | Gold value. | Silver. | | Total value. |
|---|---|---|---|---|
| | | Quantity. | Value. | |
| | | *Fine ounces.* | | |
| 1891 | $449 | | | $449 |
| 1892 | 583,010 | | | 583,010 |
| 1893 | 2,010,367 | 5,019 | $3,915 | 2,014,282 |
| 1894 | 2,908,702 | 25,900 | 16,317 | 2,925,019 |
| 1895 | 6,879,137 | 70,448 | 45,791 | 6,924,928 |
| 1896 | 7,512,911 | 60,864 | 41,387 | 7,554,298 |
| 1897 | 10,139,709 | 57,297 | 34,378 | 10,174,087 |
| 1898 | 13,507,244 | 68,195 | 40,235 | 13,547,479 |
| 1899 | 15,658,254 | 82,520 | 49,512 | 15,707,766 |
| 1900 | 18,073,539 | 80,166 | 49,703 | 18,123,242 |
| 1901 | 17,261,579 | 90,884 | 54,530 | 17,316,109 |
| 1902 | 16,912,783 | 62,690 | 33,226 | 16,946,009 |
| 1903 | 12,967,338 | 42,210 | 22,793 | 12,990,131 |
| 1904 | 14,456,536 | 47,817 | 27,734 | 14,494,270 |
| 1905 | 15,641,754 | 56,951 | 34,740 | 15,676,494 |
| 1906 | 13,930,526 | 67,943 | 46,201 | 13,976,727 |
| 1907 | 10,370,284 | 51,630 | 34,076 | 10,404,360 |
| 1908 | 13,031,917 | 52,270 | 27,703 | 13,059,620 |
| 1909 | 11,466,227 | 63,204 | 32,866 | 11,499,093 |
| 1910 | 11,002,253 | 54,263 | 29,302 | 11,031,555 |
| 1911 | 10,562,653 | 57,783 | 30,625 | 10,593,278 |
| Total | 224,877,172 | 1,098,054 | 655,034 | 225,532,206 |

[a] Figures for 1891–1903 from reports of the Director of the Mint; figures 1904–1911 actual recovery by mills and smelting. In 1907 the Portland Co. installed a cyanide plant to treat the accumulated tailings of previous years and to treat tailings from the chlorination barrels. The Colorado plant of the United States Reduction & Refining Co. is also the cyanide auxiliary plant to the Standard chlorination plant, and old tailings of previous years as well as tailings from day to day from the Standard plant are treated here.

## IDAHO.

By C. N. Gerry.

### PRODUCTION.

The value of the production of gold, silver, copper, lead, and zinc from 152 deep mines and 217 placers in Idaho in 1911 was $19,100,894, against $16,316,196 in 1910, an increase of $2,784,698. Copper was the only metal whose output decreased. The main increase was in the lead output; increases were also recorded in gold, silver, and zinc. An important increase was shown in ore production, but a slight decrease in average value of the ore per ton.

*Mine production of gold, silver, copper, lead, and zinc in Idaho in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 53,059.73 | $1,096,842 | 66,389.22 | $1,372,387 | + 13,329.49 | + $275,545 |
| Silver.....do.... | 7,369,742 | 3,979,661 | 8,196,136 | 4,343,952 | + 826,394 | + 364,291 |
| Copper.....pounds.. | 7,037,292 | 893,736 | 5,152,937 | 644,117 | − 1,884,355 | − 249,619 |
| Lead.....do.... | 228,258,839 | 10,043,389 | 272,556,525 | 12,265,044 | +44,297,686 | +2,221,655 |
| Zinc.....do.... | 5,603,114 | 302,568 | 8,340,249 | 475,394 | + 2,737,135 | + 172,826 |
| Total..... | ..... | 16,316,196 | ..... | 19,100,894 | ..... | +2,784,698 |

The State figures by years, for the last eight years, showing the effect of the industrial and financial depression of 1907 and the record lead output of 1911, are given in the following table:

*Total quantity of ore sold or treated in Idaho in 1904–1911, and content and total value of gold, silver, copper, lead, and zinc.*

| Year. | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1904..... | 1,668,327 | 82,739.00 | 7,666,382 | 5,087,518 | 233,096,375 | 2,600 | $16,933,405 |
| 1905..... | 1,669,038 | 52,033.00 | 8,679,093 | 7,321,585 | 259,812,428 | 1,228,449 | 19,743,620 |
| 1906..... | 1,787,673 | 55,587.73 | 9,018,815 | 9,558,913 | 255,014,446 | 2,065,597 | 23,698,400 |
| 1907..... | 1,690,860 | 60,754.70 | 8,415,431 | 10,890,731 | 233,823,854 | 6,985,732 | 21,793,064 |
| 1908..... | 1,689,231 | 69,827.33 | 7,469,981 | 10,041,850 | 206,827,816 | 37,410 | 15,416,599 |
| 1909..... | 1,772,383 | 70,328.64 | 7,041,633 | 9,115,489 | 215,986,285 | 1,351,010 | 15,660,849 |
| 1910..... | 1,786,174 | 53,059.73 | 7,369,742 | 7,037,292 | 228,258,839 | 5,603,114 | 16,316,196 |
| 1911..... | 2,170,897 | 66,389.22 | 8,196,136 | 5,152,937 | 272,556,525 | 8,340,249 | 19,100,894 |

The different kinds of ore produced, the metal content of each, and the number of mines producing each class of ore, for 1911, are as follows:

*Output of ore and production of metals in Idaho in 1911, by kinds of ore.*

| Source of production. | Number of producers. | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Placers..... | 217 | ..... | 19,559.35 | 4,851 | ..... | ..... | ..... |
| Siliceous ore..... | 78 | 122,708 | 38,040.41 | 332,864 | 10,354 | 18,843 | ..... |
| Copper ore..... | 9 | 40,061 | 4,492.30 | 254,095 | 3,975,384 | ..... | ..... |
| Lead ore..... | 61 | 1,559,724 | 3,843.44 | 7,059,990 | 1,049,599 | 240,412,348 | ..... |
| Zinc ore..... | 2 | 51,050 | 7.74 | 33,669 | 6,192 | 1,027,140 | 6,622,185 |
| Lead-zinc ore..... | 7 | 397,354 | 446.01 | 510,667 | 111,408 | 31,098,194 | 1,718,064 |
| Total..... | ..... | 2,170,897 | 66,389.25 | 8,196,136 | 5,152,937 | 272,556,525 | 8,340,249 |

## ORE PRODUCTION IN 1911.

The quantity of ore sold or treated increased from 1,786,174 tons in 1910 to 2,170,897 tons in 1911, an increase of 384,723 tons, or more than 21 per cent. The largest part of this in 1911, or 1,559,724 tons, was lead ore, representing nearly 72 per cent of the total. About 18 per cent, or 397,354 tons, was lead-zinc ore; 122,708 tons, or nearly 6 per cent, was siliceous ore; and about 2 per cent each were copper ore and zinc ore. The gold and silver value per ton of these ores was as follows: Siliceous, $7.85; copper, $5.68; lead, $2.45; zinc, $0.35; and lead-zinc, $0.70. Included under siliceous ore were 440 tons of iron ore containing gold and silver, and 278 tons of ore the value of which was almost entirely that of silver. Silver ores had an average value per ton of $1.36 in gold, $22.89 in silver, and $1.21 in copper; and dry or siliceous gold or gold-silver ores averaged $6.42 per ton in gold and $1.37 in silver.

*Subdivision of tonnage of ore sold or treated in Idaho in 1911, by counties, in short tons*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|
| Ada | 41 | | | | | 41 |
| Adams | | 518 | | | | 518 |
| Blaine | 2,658 | | 2,871 | | 131 | 5,660 |
| Boise | 17,376 | | | | | 17,376 |
| Bonner | 70 | | 28 | | | 98 |
| Cassia | | | 19 | | | 19 |
| Custer | 203 | 12,727 | 58 | | | 12,988 |
| Elmore | 40,007 | | | | | 40,007 |
| Fremont | | | 71 | | | 71 |
| Idaho | 7,147 | | | | | 7,147 |
| Kootenai | 19 | | | | | 19 |
| Lemhi | 7,683 | 467 | 26,915 | | | 35,065 |
| Owyhee | 47,401 | | | | | 47,401 |
| Shoshone | 103 | 26,349 | 1,529,762 | 51,050 | 397,223 | 2,004,487 |
| Total | [a] 122,708 | 40,061 | 1,559,724 | 51,050 | 397,354 | 2,170,897 |

[a] Includes 122,430 tons of gold and gold-silver ore, and 278 tons of silver ore.

Approximately 183 reduction mills were reported in Idaho in 1911, but several of them are old plants. Of this large number, 117, or 64 per cent, were idle, 3 were under construction, and 63 were in operation during all or part of the year. Of the total plants, 61 were equipped for amalgamation alone, and 14 of these were in operation. The large mills are those equipped for concentration alone, and number 40, of which 24 were active. There were 6 cyanide mills, but only 1 was active; 56 amalgamation and concentration mills, of which 15 were productive; 7 amalgamation and cyanide mills, all of which were idle; 4 concentration and cyanide plants, of which 3 were operated; and 9 amalgamation, concentration, and cyanide plants, of which 6 were active. The complete list follows.

*List of reduction mills in Idaho in 1911, by counties*

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| ADA COUNTY. | | | | *Short tons.* |
| June [a] | Black Hornet | Amalgamation | 3-foot Huntington mill. | 6 |
| Last Hope [a] | do | do | 3 stamps | 10 |
| Ironsides [a] | do | Concentration, amalgamation. | 10 Wilfley tables, 20 stamps, 3 Frue vanners. | 75 |
| Celtic [a] | McIntyre | Amalgamation, cyanidation. | 1 Blake crusher, 5 stamps. | 15 |
| Gold Eagle [a] | Neal | Amalgamation, concentration. | Chilean mill, 3 Wilfley tables, two 30-ton leaching tanks, 1 Pachuca tank. | 70 |
| Eldorado [b] | Shaw Mountain | Amalgamation | 5 stamps | 15 |
| ADAMS COUNTY. | | | | |
| Idaho Gold Coin [a] | Seven Devils | Cyanidation | 3 crushers, 5 tanks | 100 |
| Hancock [a] | do | Concentration | Huntington mills | 25 |
| BANNOCK COUNTY. | | | | |
| Fort Hall [a] | Fort Hall | Concentration | Tables | 50 |
| BONNEVILLE COUNTY. | | | | |
| Robinson [a] | Mount Pisgah | Amalgamation | 10 stamps | 30 |
| Pittsburg [a] | do | Amalgamation, concentration. | Plates, tables | 40 |
| BLAINE COUNTY. | | | | |
| Wilbert [c] | Dome | Concentration | Crusher, rolls, jigs, classifier, and Hardinge mill. | 150 |
| Cannon Ball [a] | Little Smoky | Concentration, amalgamation. | 10 stamps | 40 |
| Muldoon [b] | Little Wood River. | Concentration | Crusher, tables | 100 |
| Croesus [b] | Mineral Hill | Amalgamation, concentration. | 10 stamps, 6 Wilfley and Johnson tables, 1 Gates crusher, 2 rolls. | 100 |
| Eureka [a] | do | Concentration | Tables | 50 |
| Idaho Democrat [b] | do | do | Jig | 1 |
| Relief [b] | do | Concentration, wet and dry. | Rolls, jigs, tables, vanners. | 150 |
| Jay Gould [a] | do | Concentration | Tables | 75 |
| Red Elephant [a] | do | do | do | 50 |
| Dollarhide [a] | Rosetta | do | do | 40 |
| El Oro [b] | Skeleton Creek | Amalgamation, concentration. | 10 stamps and 2 concentrators. | 40 |
| Bear Creek [b] | Soldier | Amalgamation | 5 stamps | 20 |
| Boston-Idaho [a] | Warm Springs | Concentration | Blake crusher, rolls, 4 Wilfley tables, double Hartz jigs. | 100 |
| Independence [a] | do | do | 2 rolls, 6 Hartz jigs | 75 |
| BLAINE COUNTY. | | | | |
| Golden Glow [b] | Warm Springs | do | Rolls, jigs, and 1 crusher. | 1 |
| BOISE COUNTY. | | | | |
| Belshazzar [a] | Boise Basin | Amalgamation | 1 Blake crusher, 1 Wilfley table. | 25 |
| Boulder [a] | do | Amalgamation, concentration. | 20 stamps | 60 |
| Edna [a] | do | Cyanidation | 1 Dorr classifier | 30 |
| Golden Age [b] | do | Amalgamation, concentration. | 15 stamps and 2 Wilfley tables. | 50 |
| Golden Rod [a] | do | Amalgamation, cyanidation. | 2 Chilean mills | 25 |
| Gold Hill and Iowa [b] | do | Amalgamation, concentration, cyanidation. | 20 stamps, crushers, roller mills, tables, Frue vanners, 2 Pachuca tanks 50 tons each. | 75 |

[a] Idle in 1911. [b] Active in 1911 [c] Under construction in 1911.

*List of reduction mills in Idaho in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| BOISE COUNTY—contd. | | | | *Short tons.* |
| Last Chance and Golden Star.[a] | Boise Basin | Amalgamation, concentration. | Chilean mill | 50 |
| Old Abe [a] | do | Amalgamation | Plates | 50 |
| Washington [a] | do | Concentration, amalgamation. | 10 stamps, 2 jigs, 1 crusher. | 25 |
| Olympia [a] | Summit Flat | Amalgamation | 5 stamps, plates | 10 |
| King [a] | do | do | 8 stamps | 16 |
| Big Giant [a] | Shaw Mountain | Cyanidation | 10 stamps | 25 |
| Kentuck [a] | West View | Concentration | Tables | 50 |
| Black Pearl [a] | do | Cyanidation | 1 Dorr classifier, 1 crusher, 8 Nissen stamps, 1 Abbe tube mill, 1 crusher, rolls. | 50 |
| Leviathan [b] | do | Concentration | Tables, Frue vanners, jigs. | 50 |
| Osborne [a] | do | Amalgamation, concentration. | Plates and tables | 50 |
| I. X. L.[a] | do | do | 5 stamps, Blake crusher, rolls, and tables. | 20 |
| Lincoln [a] | do | do | Plates and tables | 140 |
| Easter [a] | do | do | Stamps | 50 |
| BONNER COUNTY. | | | | |
| Weber [a] | Lake View | Concentration, amalgamation. | 10 stamps | 50 |
| Farmer Jones [a] | Priest Lake | Amalgamation | Small Chilean mill | 5 |
| CASSIA COUNTY. | | | | |
| Dominion [a] | Albion | Amalgamation | 5 stamps | 20 |
| Cumora [a] | Stokes | Amalgamation, cyanidation. | do | 20 |
| CLEARWATER COUNTY. | | | | |
| Bond [a] | Pierce | Amalgamation | 5 stamps | 15 |
| Klondike [a] | do | Amalgamation, concentration. | do | 15 |
| Ozark and Wild Rose [a] | do | Amalgamation | do | 10 |
| Santiago [a] | do | do | 2 stamps | 5 |
| CUSTER COUNTY. | | | | |
| Dryden [b] | Bay Horse | Concentration | 1 hand jig | 2 |
| Ramshorn [a] | do | Amalgamation, concentration. | 10 stamps | 40 |
| Greyhound [a] | Sea Foam | Concentration, cyanidation. | Crusher, 4 Frue vanners, 2 slime tanks, 2 Dorr classifiers. | 40 |
| Valley Creek [a] | Stanley Basin | Amalgamation, cyanidation. | 10 stamps | 30 |
| Single Standard [a] | do | Amalgamation | 5 stamps | 15 |
| Bismark [b] | Yankee Fork | Amalgamation, concentration. | 4 Monadnock mills, plates, Blake crushers. | 75 |
| Yankee Fork [a] | do | Amalgamation | 10 stamps | 30 |
| Lucky Boy [a] | do | Amalgamation, cyanidation. | 25 stamps | 60 |
| ELMORE COUNTY. | | | | |
| Bonoparte [b] | Bear Creek | Amalgamation | 5 stamps | 15 |
| Bassler [a] | do | Amalgamation, cyanidation. | 10 stamps and 2 tanks. | 20 |
| Overlook [b] | Black Warrior | Amalgamation | 1 stamp | 2 |
| Crown Point [a] | Dixie | Amalgamation, concentration. | 10 stamps | 30 |
| Atlanta [b] | do | Amalgamation, concentration, cyanidation. | 1 crusher, rolls, 4 sets tables, jigs, 15 tanks. | 150 |
| Bagdad Chase [a] | do | do | 40 stamps, Frue vanners, slime tables, roasters, two 14-foot tube mills, 4 tanks—22 tons. | 150 |

[a] Idle in 1911. [b] Active in 1911.

*List of reduction mills in Idaho in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| ELMORE COUNTY—con. | | | | *Short tons.* |
| Big Lode [a] | Middle Boise | Amalgamation, concentration. | 20 stamps | 50 |
| Minerva [b] | do | do | 30 stamps and tables | 80 |
| Ainslie Group [a] | Neal | do | 5 stamps | 15 |
| Homestake [b] | do | Amalgamation, concentration, cyanidation. | 10 stamps | 50 |
| Franklin [b] | Pine Grove | do | do | 30 |
| Lime Creek [a] | do | Amalgamation | do | 20 |
| Provident Investment Co. [a] | do | do | do | 20 |
| IDAHO COUNTY. | | | | |
| Moscow [b] | Big Creek | Amalgamation | 1 stamp | 2 |
| Columbia [a] | do | do | 5 stamps | 15 |
| Eagle [b] | do | Concentration, cyanidation. | Tube mill and 8 stamps. | 30 |
| Pueblo [a] | do | Amalgamation | 5 stamps | 15 |
| Olivia [a] | Dixie | do | Huntington mill, 1 Blake crusher. | 10 |
| Diamond Consolidated [a] | do | do | 4 stamps | 12 |
| Dixie Royal [a] | do | do | | 15 |
| American Eagle [a] | Elk City | Amalgamation, concentration. | 10 stamps | 30 |
| Grangeville [b] | Elk City | do | 5 stamps, 1 crusher | 15 |
| Idaho Buster [a] | do | do | 10 stamps | 40 |
| Hope [a] | do | Amalgamation | 2 stamps | 3 |
| Little Butte [b] | do | Amalgamation, concentration. | 1 stamp, crusher, Frue vanner. | 1 |
| Penn Dixie [a] | do | do | 4 stamps | 15 |
| South Fork [b] | do | do | 1 Frue vanner, 5 stamps. | 20 |
| First Chance [b] | Florence | Amalgamation | 3 stamps | 10 |
| Skookum [a] | do | do | 5 stamps | 15 |
| Goodenough [a] | Marshall Lake | do | 10 stamps | 30 |
| Jewel Kimberly [a] | do | do | 2 stamps | 5 |
| Iron Crown [b] | Newsome | do | Kinkead mill, and crusher. | 15 |
| Meadow Creek [a] | do | do | 2 stamps | 2 |
| Beaver Creek [b] | do | do | Hammond mill, plates, 2 stamps. | 10 |
| N. P. [a] | do | do | 2 stamps | 5 |
| Idaho Champion [b] | Orogrande | Amalgamation, concentration. | 10 stamps, 2 tables, 1 Blake crusher. | 25 |
| Butte and Orogrande [a] | do | Cyanidation | 20 stamps | 100 |
| Iola [a] | do | Amalgamation, concentration. | 1 Frue vanner, 2 stamps. | 7 |
| Twin Butte [a] | do | Amalgamation, cyanidation. | Roller mill | 300 |
| Cracker Jack [a] | Robbins | Amalgamation, concentration. | 20 stamps | 60 |
| Buffalo Hump [a] | do | Amalgamation | 10 stamps | 40 |
| Jumbo [b] | do | Amalgamation, concentration, cyanidation. | 24 stamps, crusher, 3 Wilfley tables, 4 100-ton cyanide tanks being installed in 1912. | 60 |
| Wiseboy [a] | do | Amalgamation, concentration. | 10 stamps, plates, 2 6-foot Frue vanners. | 40 |
| McKinley [a] | Simpson | Amalgamation | 1 stamp | 2 |
| Buckhorn [b] | Ten Mile | do | 5 stamps | 15 |
| Belle of Thunder Mountain. [a] | Thunder Mountain. | do | 40 stamps | 200 |
| Dewey [b] | do | do | 10 stamps | 40 |
| Thunder Mountain [a] | do | do | 20 stamps | 60 |
| Trappers Flat [a] | Warm Lake | do | 10 stamps | 30 |
| White Monument [b] | Warren | do | 3 stamps and 1 Blake crusher. | 3 |
| Thunder Mountain Gold Reef. [b] | do | Amalgamation, concentration. | Ellspass mill, 1 crusher, and 2 tables. | 25 |
| Silver King [b] | do | do | 10 stamps | 30 |
| Skylark [a] | do | Amalgamation | 1 stamp | 1 |
| Silver Fork [b] | do | do | do | 1 |

[a] Idle in 1911. [b] Active in 1911.

*List of reduction mills in Idaho in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| LATAH COUNTY. | | | | *Short tons.* |
| Eureka e. a.[a] | Gold Creek | Amalgamation, concentration, cyanidation. | 1 crusher | 10 |
| Mountain Gulch[a] | Hoodoo | Amalgamation, concentration. | Huntington mill, 2 stamps. | 2 |
| White Cross[a] | Moscow | do | 5 stamps | 10 |
| LEMHI COUNTY. | | | | |
| Oro Cache[b] | Carmen Creek | Amalgamation | 10 stamps and 1 crusher. | 10 |
| Eldorado[a] | Eldorado | Amalgamation, concentration. | 10 stamps | 30 |
| Copper Queen[a] | Eureka | do | 15 stamps | 50 |
| Eureka[a] | do | Amalgamation | 5 stamps | 15 |
| U. P. & Burlington[a] | do | do | 10 stamps | 30 |
| Rabbit Foot[a] | Gravel Range | Amalgamation, concentration. | do | 30 |
| Twin Brother[a] | Gibbonsville | do | do | 30 |
| American D. M. & R. Co.[b] | do | Amalgamation, concentration, cyanidation. | 10-ton cyanide plant, 5 tanks, 3 tables, and 15 stamps. | 30 |
| Kittie Burton[b] | Indian Creek | Amalgamation, concentration. | 15 stamps, tables, and crusher. | 30 |
| Italian[b] | Mackinaw | do | 30 stamps | 60 |
| Bloodhound[a] | do | Amalgamation | 10 stamps | 30 |
| Gold Dust[a] | do | Amalgamation, concentration. | 20 stamps | 40 |
| Gold Ridge[a] | do | Cyanidation | 10 stamps | 30 |
| Clipper Bullion[a] | Mineral Hill | Amalgamation | 5 stamps | 15 |
| Monolith[a] | do | do | 20 stamps | 40 |
| Speculation[a] | do | do | 10 stamps | 30 |
| Climax[a] | Pratt Creek | Amalgamation, concentration. | 10 stamps, 1 Blake crusher, 2 vanners. | 25 |
| Black Eagle[a] | Yellow Jacket | do | 2 stamps | 3 |
| Idaho Yellow Jacket[a] | do | Amalgamation | 60 stamps | 100 |
| Parker[a] | Unorganized | Amalgamation, concentration. | Roll mill | 6 |
| OWYHEE COUNTY. | | | | |
| Addie Consolidated[a] | Carson | Amalgamation, concentration. | 5 stamps | 15 |
| Banner[b] | do | do | 4 Nissen stamps, Johnson and Wilfley tables, cone tank, pans, settlers. | 30 |
| De Lamar[b] | do | Concentration, cyanidation. | 2 Dorr classifiers, tanks. | 150 |
| Pauper[a] | do | Amalgamation | 2 stamps | 2 |
| Potosi[a] | do | Amalgamation, concentration. | Tube mill, 5 stamps | 25 |
| Poorman[a] | do | Amalgamation | 10 stamps | 30 |
| OWYHEE COUNTY. | | | | |
| Bergh Mining Company.[b] | do | Amalgamation, concentration. | 5 stamps, crusher, plates, tables. | 15 |
| Rich Gulch[c] | do | do | | 100 |
| Trade Dollar[a] | do | do | 20 stamps | 40 |
| Golden Crown[b] | Castle Creek | Concentration, cyanidation. | 3 Hendy stamps, 15-ton cyanide tank, 20 stamps. | 15 |
| Rising Star[a] | Flint Creek | Amalgamation, concentration. | 20 stamps | 50 |
| Cumberland[a] | French | Amalgamation | 10 stamps, 1 crusher | 20 |
| SHOSHONE COUNTY. | | | | |
| Wake Up Jim[a] | Beaver | Amalgamation | 10-stamp mill | 30 |
| Buckeye Boy[a] | Cœur d'Alene | do | 2 stamps, crusher | 5 |
| Golden Winnie[a] | do | Amalgamation, concentration. | Chilean mills and rolls. | 20 |
| Charles Dickens[a] | Evolution | Concentration | Mill | 150 |
| Alice[b] | Hunter | do | do | 125 |

[a] Idle in 1911. [b] Active in 1911. [c] Under construction in 1911.

*List of reduction mills in Idaho in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| SHOSHONE COUNTY—continued. | | | | *Short tons.* |
| Morning [a] | Hunter | Concentration | Crushers, Huntington, Hardinge mills, tube mill, jigs, tables, Frue vanners. | 1,000 |
| Gold Hunter [a] | do | do | Rolls, jigs, vanners, Huntington mills. | 300 |
| Snow Storm [b] | do | do | | 200 |
| Mace [a] | Lelande | do | 2 crushers, vanners, 2 sets rolls, 28 Hartz jigs, 10 Wilfley tables. | 600 |
| Burke [c] | do | do | Crushers, jigs, and tables. | 600 |
| Hercules [a] | do | do | 1 crusher, 2 sets of rolls, 40 tables. | 600 |
| Hecla [a] | do | do | Crushers, jigs, and tables. | 300 |
| Frisco [c] | do | do | do | 500 |
| 16-to-1 or Rex [a] | Placer Center | do | do | 400 |
| Pittsburg [a] | do | do | do | 250 |
| Success [a] | do | do | do | 150 |
| Monarch [a] | Summit | do | do | 200 |
| Mother Lode [a] | do | Amalgamation | 5 stamps | 15 |
| Bear Top [a] | do | Concentration | Tables, etc | 150 |
| Daddy [c] | do | Amalgamation, concentration. | 1 crusher, 10 stamps, 3 tables. | 50 |
| Golden Reward [c] | do | do | 10 stamps, tables | 30 |
| King [c] | do | Amalgamation | 5 stamps | 15 |
| Golden Chest [c] | do | Amalgamation, concentration. | 20 stamps | 50 |
| Black Horse [a] | do | Concentration | 2 sets rolls, 1 crusher, 6 Hartz jigs, 3 Wilfley tables. | 150 |
| Bunker Hill (North mill). [a] | Yreka | For tailings concentration. | 5 crushers, Huntington, Chilean, and Hardinge mills, 38 Card and 40 Wilfley tables, 90 Frue vanners. | 800 |
| Bunker Hill (South mill). [a] | do | Concentration | do | 1,000 |
| Bunker Hill (West mill) [a] (Unit No. 1). [d] | do | do | do | 550 |
| Silver King [a] | do | do | 1 Blake crusher, 4 jigs, 6 tables. | 150 |
| Wardner (Last Chance). [a] | do | Wet concentration | Crushers, jigs, and tables. | 500 |
| Hypotheck [c] | do | Concentration | 1 crusher, rolls, Huntington mills, tables, jigs. | 70 |
| Senator Stewart (leased Federal mill at Wallace). [c] | do | do | Crushers, jigs, and tables. | 150 |
| New Jersey [c] | do | Amalgamation | 10 stamps | 30 |
| Surprise [a] | do | Concentration | 1 crusher, 8 Wilfley tables, 6 jigs. | 100 |

[a] Active in 1911. [b] Under construction 1911. [c] Idle in 1911. [d] Unit No. 2 being completed.

Over 5 per cent of the ore, or 114,461 tons, was treated in gold and silver mills, and had a bullion value of $876,615, or $7.66 per ton. Included in this bullion was some gold and silver from 4,967 tons of old tailings, not included in the tonnage above. Of the gold in bullion, nearly 57 per cent was secured by the cyanidation of 42,251 tons, while the remainder was won by the amalgamation of 72,210 tons. From incomplete returns in regard to the use of mercury and potassium and sodium cyanide, it was estimated that approximately 1,648 pounds of mercury were consumed in amalgamation mills, or about 0.023 pound per ton of ore treated and about 0.057

pound to each ounce of bullion recovered. In mills equipped for the cyanide process, 171,808 pounds of potassium cyanide and 10,000 pounds of sodium cyanide were used, showing an average of about 4.3 pounds per ton of ore cyanided, and about 0.63 pound for each ounce of bullion recovered by cyanidation.

*Tonnage of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Idaho in 1911, by counties.*

| County. | Quantity. | Bullion recovered from ore by— | | | | Total value. |
|---|---|---|---|---|---|---|
| | | Amalgamation. | | Cyanidation. | | |
| | | Gold. | Silver. | Gold. | Silver. | |
| | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Fine ozs.* | *Fine ozs.* | |
| Ada | 41 | 35.99 | 13 | | | $751 |
| Blaine | [a] 2,541 | 578.06 | 301 | 164.07 | 2,576 | 16,866 |
| Boise | [b] 14,837 | 3,175.49 | 888 | 273.57 | 212 | 71,881 |
| Custer | 203 | 63.04 | 54 | | | 1,332 |
| Elmore | [c] 40,005 | 5,551.59 | 6,344 | 4,755.04 | 10,474 | 221,971 |
| Idaho | [d] 7,125 | 2,696.22 | 941 | | | 56,235 |
| Lemhi | [e] 7,226 | 2,540.80 | 302 | 142.49 | 18 | 55,638 |
| Owyhee | [f] 42,433 | 647.96 | 4,903 | 14,578.12 | 253,039 | 451,460 |
| Shoshone | 50 | 23.11 | 7 | | | 481 |
| Total | 114,461 | 15,312.26 | 13,753 | 19,913.29 | 266,319 | 876,615 |

[a] Also yielded 17 tons of concentrates; [b], 21 tons; [c], 359 tons; [d], 1 ton; [e], 154 tons; [f], 145 tons. These tonnages and metal content are included in table of concentrates produced.

Nearly 84 per cent of the total ore, or 1,820,719 tons, was concentrated, and, at a ratio of 8.1 to 1, made 222,748 tons of concentrates, valued at $12,573,367, or $56.45 per ton. This tonnage of concentrates also includes those from the treatment of 93,818 tons of old tailings. Over 93 per cent was lead concentrates, 5 per cent lead-zinc concentrates, and less than 1 per cent siliceous concentrates. There were 697 tons of concentrates from gold and silver mills, but the greatest quantity, in fact over 99 per cent, came from Cœur d'Alene ore.

*Mine production of gold, silver, copper, lead, and zinc from Idaho concentrates in 1911, by counties.*

| County. | Ore to concentrating mills. | Concentrates produced. | | | | | | Total value of concentrates. |
|---|---|---|---|---|---|---|---|---|
| | | Quantity. | Gold. | Silver. | Copper | Lead. | Zinc. | |
| | *Short tons.* | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Blaine | 462 | 340 | 90.62 | 10,013 | 2,301 | 142,038 | 14,722 | $14,699 |
| Boise | 2,340 | 814 | 424.74 | 1,346 | 3,096 | | | 9,880 |
| Elmore | | 359 | 1,048.96 | 1,031 | | 4,100 | | 22,415 |
| Idaho | | 1 | 3.77 | 188 | | | | 178 |
| Lemhi | | 154 | 251.90 | 64 | 116 | 5,538 | | 5,504 |
| Owyhee | | 145 | 292.97 | 32,796 | | 1,639 | | 23,511 |
| Shoshone | 1,817,917 | 220,935 | 2,610.27 | 5,175,968 | 593,338 | 203,424,597 | 8,275,155 | 12,497,180 |
| Total | 1,820,719 | 222,748 | 4,723.23 | 5,221,406 | 598,851 | 203,577,912 | 8,289,877 | 12,573,367 |
| Subdivision by kinds of concentrates: | | | | | | | | |
| Dry or siliceous | | 1,482 | 2,068.96 | 35,374 | 3,212 | 9,968 | | 62,367 |
| Lead | | 209,068 | 2,654.27 | 5,185,972 | 595,639 | 203,566,744 | | 12,038,392 |
| Zinc | | 12,198 | | 60 | | 1,200 | 8,289,877 | 472,608 |

The lead concentrate had an average value per ton of $57.58 for 24.81 ounces of silver and 48.69 per cent lead. There was a large increase in zinc concentrate, which had an average value of $38.74 per ton.

*Kinds of concentrates and average metallic content of milling ore and concentrates produced in Idaho in 1911.*

| Kinds of concentrates and source of production. | Milling ore. | Concentrate. | Average metallic content per ton. | | | | | | | | | | Average value per ton. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gold. | | Silver. | | Copper. | | Lead. | | Zinc. | | | |
| | | | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. |
| Dry or siliceous: | *Short tons.* | *Short tons.* | | | *Fine oz.* | *Fine oz.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | | |
| Gold and silver mills | 89,652 | 689 | $0.39 | $51.00 | 0.36 | 46.82 | ..... | 0.06 | ..... | 0.70 | ..... | ..... | $0.59 | $76.61 |
| Concentration mills | 2,340 | 793 | 3.25 | 9.62 | 1.33 | 3.93 | 0.05 | .15 | ..... | .02 | ..... | ..... | 4.09 | 12.08 |
| Lead: | | | | | | | | | | | | | | |
| Gold and silver mills | 500 | 8 | .72 | 45.00 | .20 | 12.50 | ..... | ..... | 0.16 | 10.24 | ..... | ..... | .97 | 60.88 |
| Concentration mills | 1,818,379 | 209,060 | .03 | .26 | 2.85 | 24.81 | .01 | .14 | 5.60 | 48.69 | ..... | ..... | 6.62 | 57.58 |
| Zinc: | | | | | | | | | | | | | | |
| Concentration mills | 448,213 | 12,198 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.92 | 33.98 | 1.05 | 38.74 |

A little over 6 per cent of the ore, or 136,932 tons, was first-class ore shipped to smelters. It was valued at $5,244,013, or $38.30 per ton, and came principally from Shoshone County, but partly from Lemhi and Custer counties. The crude ore was also largely lead ore, only 29 per cent being copper ore and less than 1 per cent siliceous ore. There was no custom smelter operating in Idaho during the year, the only smelting done in the State being a short run at the Lost Packer mine, in Custer County. Ore and concentrate are shipped to various plants in Tacoma, East Helena, Butte, Denver, and California.

*Mine production of gold, silver, copper, lead, and zinc from Idaho crude ore shipped to smelters in 1911, by counties.*

| County. | Crude ore to smelter. | | | | | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Adams | 518 | 15.97 | 978 | 132,966 | ..... | ..... | $17,469 |
| Blaine | 767 | 199.14 | 34,947 | 7,058 | 563,507 | 15,092 | 49,739 |
| Boise | 199 | 368.54 | 1,290 | 2,258 | 2,773 | ..... | 8,709 |
| Bonner | 98 | 6.73 | 7,748 | 2,045 | 6,822 | ..... | 4,808 |
| Cassia | 19 | 14.85 | 167 | ..... | 10,455 | ..... | 867 |
| Custer | 12,785 | 3,944.35 | 52,444 | 1,685,224 | 54,252 | ..... | 322,427 |
| Elmore | 2 | ..... | 516 | ..... | ..... | ..... | 273 |
| Fremont | 71 | .15 | 342 | ..... | 78,337 | ..... | 3,709 |
| Idaho | 22 | 10.50 | 34 | 312 | ..... | ..... | 274 |
| Kootenai | 19 | ..... | 645 | 466 | 671 | ..... | 430 |
| Lemhi | 27,839 | 1,305.65 | 382,520 | 390,544 | 16,849,384 | ..... | 1,036,766 |
| Owyhee | 1 | 1.34 | 355 | ..... | ..... | ..... | 216 |
| Shoshone | 94,592 | 1,013.90 | 2,207,821 | 2,333,213 | 51,412,412 | 35,280 | 3,798,326 |
| Total | 136,932 | 6,881.12 | 2,689,807 | 4,554,086 | 68,978,613 | 50,372 | 5,244,013 |
| Subdivision by kinds of ore: | | | | | | | |
| Dry or siliceous | 940 | 728.47 | 17,318 | 7,142 | 7,236 | ..... | 25,457 |
| Copper | 40,061 | 4,492.31 | 254,095 | 3,975,384 | ..... | ..... | 724,457 |
| Lead | 95,840 | 1,656.43 | 2,417,954 | 571,560 | 68,954,118 | ..... | 4,490,137 |
| Zinc | 50 | ..... | 99 | ..... | ..... | 35,280 | 2,063 |
| Lead-zinc | 41 | 3.91 | 341 | ..... | 17,259 | 15,092 | 1,899 |

The crude ore shipped to smelters was nearly 30 per cent copper ore and 70 per cent lead ore.

*Crude ore, by kinds, and average metallic content of each kind shipped to smelters in Idaho in 1911.*

| Kind of crude ore. | Quantity. | Average metallic content per ton. | | | | | Average value per ton. |
|---|---|---|---|---|---|---|---|
| | | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | | *Fine ounces.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Dry or siliceous | 940 | $16.02 | 18.42 | 0.38 | 0.39 | ..... | $27.08 |
| Copper | 40,061 | 2.32 | 6.34 | 4.96 | ..... | ..... | 18.08 |
| Lead | 95,840 | .36 | 25.23 | .30 | 35.97 | ..... | 46.85 |
| Zinc | 50 | ..... | 1.98 | ..... | ..... | 35.28 | 41.26 |
| Lead-zinc | 41 | 1.97 | 8.32 | ..... | 21.05 | 18.41 | 46.32 |

## GOLD.

The production of gold in Idaho increased from 53,059.73 ounces, valued at $1,096,842 in 1910, to 66,389.22 ounces, valued at $1,372,387 in 1911, an increase of 13,329.49 ounces in quantity and of $275,545 in value. From 152 deep mines $968,060 in gold was produced, largely in Owyhee and Elmore counties. This was an increase from $854,296 from deep mines in 1910. From 217 placers $404,327 in gold was taken out, principally by dredge operations, which accounts for the increase from an output of $242,546 in 1910. Owyhee County had been the premier gold producer, but since the Trade Dollar mine at Silver City was closed Boise County has taken first place. Of the placer output of 19,559.32 ounces, the greater part, or 12,519.04 ounces, came from dredging by 7 boats, 78.02 ounces from drift mining on 6 properties, and 6,962.26 ounces from hydraulic or sluicing operations on 204 placers. The greater part of the gold, or 57.30 per cent, came, as formerly, from siliceous ore, 29.46 per cent from placers, 6.76 per cent from copper ore, and 5.78 per cent from lead ore. Siliceous ore contained $6.40 in gold per ton, copper ore $2.27, and lead ore only $0.04. Gold valued at $4,691 was taken from placers on Snake River. This is considerably less than in past years. Of the total gold output, 53 per cent was recovered from mill bullion, 15,312.26 ounces by amalgamation, and 19,913.29 ounces by cyanidation. Ore treated by amalgamation yielded $4.38 in gold per ton, that by cyanidation $6.91 per ton. Concentrates contained a little more than 7 per cent, or 4,723.23 ounces, and crude ore shipped to smelters, 10.36 per cent, or 6,881.12 ounces. Ore sent to gold and silver mills, therefore, had a value in gold of $6.36 per ton, concentrates produced $0.44 per ton, and crude ore, shipped, $1.04 per ton.

*Source of gold production in Idaho, by kinds of ore, in 1911, by counties, in fine ounces.*

| County. | Placers. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|
| Ada | 105.60 | 35.99 | | | | | 141.59 |
| Adams | 35.60 | | 15.97 | | | | 51.57 |
| Bingham | 79.87 | | | | | | 79.87 |
| Blaine | 11.66 | 920.33 | | 110.21 | | 1.35 | 1,043.55 |
| Boise | 12,856.48 | 4,242.34 | | | | | 17,098.82 |
| Bonner | 1.98 | 6.73 | | | | | 8.71 |
| Bonneville | 138.35 | | | | | | 138.35 |
| Canyon | 9.58 | | | | | | 9.58 |
| Cassia | 3.82 | | | 14.85 | | | 18.67 |
| Clearwater | 1,971.57 | | | | | | 1,971.57 |
| Custer | 339.64 | 63.05 | 3,943.78 | .56 | | | 4,347.03 |
| Elmore | 171.54 | 11,355.59 | | | | | 11,527.13 |
| Fremont | 2.85 | | | .15 | | | 3.00 |
| Idaho | 931.95 | 2,710.49 | | | | | 3,642.44 |
| Kootenai | 520.90 | | | | | | 520.90 |
| Latah | 45.96 | | | | | | 45.96 |
| Lemhi | 1,621.68 | 3,161.72 | 359.59 | 719.53 | | | 5,862.52 |
| Lincoln | 10.16 | | | | | | 10.16 |
| Oneida | 12.33 | | | | | | 12.33 |
| Owyhee | 66.18 | 15,520.39 | | | | | 15,586.57 |
| Shoshone | 514.66 | 23.78 | 172.96 | 2,998.14 | 7.74 | 444.66 | 4,161.94 |
| Twin Falls | 99.22 | | | | | | 99.22 |
| Washington | 7.74 | | | | | | 7.74 |
| Total | 19,559.32 | [a] 38,040.41 | 4,492.30 | 3,843.44 | 7.74 | 446.01 | 66,389.22 |

[a] Includes 38,022.13 ounces from gold and gold-silver ores and 18.28 ounces from silver ores

## SILVER.

The production of silver increased from 7,369,742 ounces, valued at $3,979,661, in 1910, to 8,196,136 ounces, valued at $4,343,952, in 1911, an increase of 826,394 ounces in quantity and of $364,291 in value. The lead mines had exceptionally large outputs, and as a result, silver production from lead and lead-zinc ores increased to a marked degree. On the other hand, the silver output from copper ores and siliceous ores decreased. About 86 per cent of the silver came from lead ore, about 6 per cent from lead-zinc ore, 3 per cent from copper ore, and 4 per cent from siliceous ore. The average silver content of the siliceous ore was 2.71 ounces; copper ore, 6.34 ounces; lead ore, 4.53 ounces; zinc ore, 0.66 ounce; and lead-zinc ore, 1.28 ounces. There were 280,072 ounces recovered from bullion, 13,753 ounces by amalgamation, or 0.11 ounce per ton, and 266,319 ounces by cyanidation, or 6.3 ounces per ton. Silver production from concentrates—mostly lead and lead-zinc concentrates—amounted to 5,221,406 ounces, or 63.7 per cent of the total, or 23.5 ounces per ton. Crude ore shipped contained 2,689,807 ounces, or 19.64 ounces per ton, and was 32.82 per cent of the silver output.

*Source of silver production in Idaho, by kinds of ore, in 1911, by counties, in fine ounces.*

| County. | Placers. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|
| Ada | 25 | 13 | | | | | 38 |
| Adams | 10 | | 978 | | | | 988 |
| Bingham | 4 | | | | | | 4 |
| Blaine | 2 | 4,396 | | 43,110 | | 331 | 47,839 |
| Boise | 3,572 | 3,736 | | | | | 7,308 |
| Bonner | | 7,113 | | 635 | | | 7,748 |
| Bonneville | 5 | | | | | | 5 |
| Canyon | 2 | | | | | | 2 |
| Cassia | | | | 167 | | | 167 |
| Clearwater | 523 | | | | | | 523 |
| Custer | 135 | 54 | 48,791 | 3,653 | | | 52,633 |
| Elmore | 47 | 18,365 | | | | | 18,412 |
| Fremont | | | | 342 | | | 342 |
| Idaho | 175 | 1,163 | | | | | 1,338 |
| Kootenai | 54 | 645 | | | | | 699 |
| Latah | 11 | | | | | | 11 |
| Lemhi | 135 | 3,877 | 2,568 | 376,459 | | | 383,039 |
| Lincoln | 1 | | | | | | 1 |
| Owyhee | 40 | 291,093 | | | | | 291,133 |
| Shoshone | 103 | 2,409 | 201,758 | 6,635,624 | 33,669 | 510,336 | 7,383,899 |
| Twin Falls | 6 | | | | | | 6 |
| Washington | 1 | | | | | | 1 |
| Total | 4,851 | [a] 332,864 | 254,095 | 7,059,990 | 33,669 | 510,667 | 8,196,136 |

[a] Includes 316,511 ounces from gold and gold-silver ores and 16,353 ounces from silver ores.

## COPPER.

The production of copper in Idaho decreased from 7,037,292 pounds, valued at $893,736, in 1910, to 5,152,937 pounds, valued at $644,117, in 1911, owing to the decrease in Shoshone County. The production in Custer County, however, increased from 919,648 pounds to 1,685,224 pounds, as a result of the operations of the White Knob and Lost Packer mines. Copper ores yielded 3,975,384 pounds, or 77 per cent of the output, and 20 per cent was derived from lead ores of Shoshone and Lemhi counties. Crude ores shipped

to smelters supplied 4,554,086 pounds, or 88.38 per cent of the total copper, and concentrates contained 598,851 pounds, or 11.62 per cent. The Lost Packer smelter was run for a short time, and shipments were greatly increased from the White Knob mine, near Mackay. The total copper ore had an average content of 4.96 per cent copper, and lead ore contained only 0.03 per cent copper.

*Source of copper production in Idaho, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|
| Adams | | 132,966 | | | | 132,966 |
| Blaine | 915 | | 8,444 | | | 9,359 |
| Boise | 5,354 | | | | | 5,354 |
| Bonner | 1,932 | | 113 | | | 2,045 |
| Custer | | 1,684,588 | 636 | | | 1,685,224 |
| Idaho | 312 | | | | | 312 |
| Kootenai | 466 | | | | | 466 |
| Lemhi | 116 | 280,200 | 110,344 | | | 390,660 |
| Shoshone | 1,259 | 1,877,630 | 930,062 | 6,192 | 111,408 | 2,926,551 |
| Total | [a] 10,354 | 3,975,384 | 1,049,599 | 6,192 | 111,408 | 5,152,937 |

[a] Includes 6,697 pounds from gold and gold-silver ores and 3,657 pounds from silver ores.

## LEAD.

The output of lead in Idaho in 1911 was 272,556,525 pounds, valued at $12,265,044, against 228,258,839 pounds, valued at $10,043,389, in 1910, an increase of 44,297,686 pounds, and was greater than the record production of 1905. Crude ore shipped to smelters contained 68,978,613 pounds, or over 25 per cent, and concentrates, largely from Shoshone County, 203,577,912 pounds, or nearly 75 per cent. The production of Blaine County decreased 579,421 pounds, while that of Lemhi County showed an increase of 10,328,448 pounds, and that of Shoshone County an increase of 35,078,967 pounds. Lead-zinc ore supplied over 11 per cent of the lead output, zinc ore less than 1 per cent, and lead ore the remainder, or 88.20 per cent. The lead ore as mined had an average of 7.70 per cent lead and the lead-zinc ore an average of 3.91 per cent.

*Source of lead production in Idaho, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Dry or siliceous ore. | Lead ore. | Zinc ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|
| Blaine | 2,138 | 697,748 | | 5,659 | 705,545 |
| Boise | 2,773 | | | | 2,773 |
| Bonner | 1,984 | 4,838 | | | 6,822 |
| Cassia | | 10,455 | | | 10,455 |
| Custer | | 54,252 | | | 54,252 |
| Elmore | 4,100 | | | | 4,100 |
| Fremont | | 78,337 | | | 78,337 |
| Kootenai | 671 | | | | 671 |
| Lemhi | 5,538 | 16,849,384 | | | 16,854,922 |
| Owyhee | 1,639 | | | | 1,639 |
| Shoshone | | 222,717,334 | 1,027,140 | 31,092,535 | 254,837,009 |
| Total | [a] 18,843 | 240,412,348 | 1,027,140 | 31,098,194 | 272,556,525 |

[a] Includes 14,925 pounds from gold and gold-silver ores and 3,918 pounds from silver ores.

### ZINC.

Idaho made a record production of zinc ore in 1911. The output of zinc was 8,340,249 pounds, valued at $475,394, in 1911, against 5,603,114 pounds, valued at $302,568, in 1910, an increase of 2,737,135 pounds in quantity and of $172,826 in value. Shoshone County continued to furnish most of the zinc, but zinc-ore shipments were made from four districts in the Cœur d'Alene region also. Zinc ore before concentration averaged 6.48 per cent of zinc. Part of the product was derived from the separation of lead-zinc ore, which contained an average of 0.21 per cent of zinc before concentration.

*Source of zinc production in Idaho, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Zinc ore. | Lead-zinc ore. | Total. |
|---|---|---|---|
| Blaine | | 29,814 | 29,814 |
| Shoshone | 6,622,185 | 1,688,250 | 8,310,435 |
| Total | 6,622,185 | 1,718,064 | 8,340,249 |

### MINING INDUSTRY IN IDAHO IN 1911.

The year 1911 was notable for quiet, persistent production, especially of lead and zinc ore. There being none of the usual interruptions, such as strikes, snowslides, and abnormal flurries in metal prices, the figures of output were comparatively high. On the other hand, no new mines of note were announced. The market for lead-silver ore was good, competition being keener since the International Smelting Co. began to make contracts with the lead producers. The milling capacity, particularly in the Cœur d'Alene region, was greatly increased, and use was made of Macquisten tubes and finer grinding in ball mills. A plant of 119 tubes was in use at the Morning mine, at Mullan. The new Hercules mill, at Wallace, was put in operation in April. Mills at Murray were improved, and sorting plants were added at various mines. The demand for zinc concentrate has brought several of the properties of Shoshone County to the stage of separating a zinc product from lead-zinc ore. There was no material change in railroad facilities nor smelter conditions, but two new dredges were completed and assisted in increasing the gold output. A dredge having a capacity of 8,000 cubic yards per day was operated for the first time at Idaho City, and another having a capacity of 5,000 cubic yards had an initial run near Salmon.

*Mine production of gold, silver, copper, lead, and zinc in Idaho in 1911, by counties.*

| County. | Gold. | | | | Silver. | |
|---|---|---|---|---|---|---|
| | Placers. | | Deep mines. | | | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | *Fine ounces.* | | *Fine ounces.* | | *Fine ounces.* | |
| Ada | 105.60 | $2,183 | 35.99 | $744 | 38 | $20 |
| Adams | 35.60 | 736 | 15.97 | 330 | 988 | 524 |
| Bingham | 79.87 | 1,651 | ..... | ..... | 4 | 2 |
| Blaine | 11.66 | 241 | 1,031.89 | 21,331 | 47,839 | 25,355 |
| Boise | 12,856.48 | 265,767 | 4,242.34 | 87,697 | 7,308 | 3,873 |
| Bonner | 1.98 | 41 | 6.73 | 139 | 7,748 | 4,106 |
| Bonneville | 138.35 | 2,860 | ..... | ..... | 5 | 3 |
| Canyon | 9.58 | 198 | ..... | ..... | 2 | 1 |
| Cassia | 3.82 | 79 | 14.85 | 307 | 167 | 89 |
| Clearwater | 1,971.57 | 40,756 | ..... | ..... | 523 | 277 |
| Custer | 339.64 | 7,021 | 4,007.39 | 82,840 | 52,633 | 27,895 |
| Elmore | 171.54 | 3,546 | 11,355.59 | 234,741 | 18,412 | 9,758 |
| Fremont | 2.85 | 59 | .15 | 3 | 342 | 181 |
| Idaho | 931.95 | 19,265 | 2,710.49 | 56,031 | 1,338 | 709 |
| Kootenai | 520.90 | 10,768 | ..... | ..... | 699 | 370 |
| Latah | 45.96 | 950 | ..... | ..... | 11 | 6 |
| Lemhi | 1,621.68 | 33,523 | 4,240.84 | 87,666 | 383,039 | 203,011 |
| Lincoln | 10.16 | 210 | ..... | ..... | 1 | 1 |
| Oneida | 12.33 | 255 | ..... | ..... | ..... | ..... |
| Owyhee | 66.18 | 1,368 | 15,520.39 | 320,835 | 291,133 | 154,301 |
| Shoshone | 514.66 | 10,639 | 3,647.28 | 75,396 | 7,383,899 | 3,913,466 |
| Twin Falls | 99.22 | 2,051 | ..... | ..... | 6 | 3 |
| Washington | 7.74 | 160 | ..... | ..... | 1 | 1 |
| Total | 19,559.32 | 404,327 | 46,829.90 | 968,060 | 8,196,136 | 4,343,952 |

| County. | Copper. | | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | *Pounds.* | | |
| Ada | ..... | ..... | ..... | ..... | ..... | ..... | $2,947 |
| Adams | 132,966 | $16,621 | ..... | ..... | ..... | ..... | 18,211 |
| Bingham | ..... | ..... | ..... | ..... | ..... | ..... | 1,653 |
| Blaine | 9,359 | 1,170 | 705,545 | $31,750 | 29,814 | $1,699 | 81,546 |
| Boise | 5,354 | 669 | 2,773 | 125 | ..... | ..... | 358,131 |
| Bonner | 2,045 | 256 | 6,822 | 307 | ..... | ..... | 4,849 |
| Bonneville | ..... | ..... | ..... | ..... | ..... | ..... | 2,863 |
| Canyon | ..... | ..... | ..... | ..... | ..... | ..... | 199 |
| Cassia | ..... | ..... | 10,455 | 471 | ..... | ..... | 946 |
| Clearwater | ..... | ..... | ..... | ..... | ..... | ..... | 41,033 |
| Custer | 1,685,224 | 210,653 | 54,252 | 2,441 | ..... | ..... | 330,850 |
| Elmore | ..... | ..... | 4,100 | 185 | ..... | ..... | 248,230 |
| Fremont | ..... | ..... | 78,337 | 3,525 | ..... | ..... | 3,768 |
| Idaho | 312 | 39 | ..... | ..... | ..... | ..... | 76,044 |
| Kootenai | 466 | 58 | 671 | 30 | ..... | ..... | 11,226 |
| Latah | ..... | ..... | ..... | ..... | ..... | ..... | 956 |
| Lemhi | 390,660 | 48,832 | 16,854,922 | 758,471 | ..... | ..... | 1,131,503 |
| Lincoln | ..... | ..... | ..... | ..... | ..... | ..... | 211 |
| Oneida | ..... | ..... | ..... | ..... | ..... | ..... | 255 |
| Owyhee | ..... | ..... | 1,639 | 74 | ..... | ..... | 476,578 |
| Shoshone | 2,926,551 | 365,819 | 254,837,009 | 11,467,665 | 8,310,435 | 473,695 | 16,306,680 |
| Twin Falls | ..... | ..... | ..... | ..... | ..... | ..... | 2,054 |
| Washington | ..... | ..... | ..... | ..... | ..... | ..... | 161 |
| Total | 5,152,937 | 644,117 | 272,556,525 | 12,265,044 | 8,340,249 | 475,394 | 19,100,894 |

*Gold production of Idaho placers by different methods in 1910 and 1911.*

| | Hydraulic.[a] | Drift. | Dredge. | Total. |
|---|---|---|---|---|
| 1910 ..... fine ounces.. | 7,272.10 | 46.99 | 4,414.07 | 11,733.16 |
| 1911 ..... do.... | 6,962.26 | 78.02 | 12,519.04 | 19,559.32 |

[a] Includes sluicing.

*Tons of ore sold or treated, number of deep mines producing, and value of ores in Idaho in 1910 and 1911, by counties.*

| County. | Ore sold or treated. | | Number of deep mines producing. | | Average total value per ton.[a] | | Average value per ton in gold and silver.[a] | |
|---|---|---|---|---|---|---|---|---|
| | 1911 | Increase (+) or decrease (−). | 1910 | 1911 | 1910 | 1911 | 1910 | 1911 |
| | *Short tons.* | *Short tons.* | | | | | | |
| Ada | 41 | − 90 | 4 | 2 | $9.56 | $18.32 | $9.53 | $18.32 |
| Adams | 518 | + 14 | 6 | 2 | 7.47 | 33.72 | 4.55 | 1.64 |
| Bannock | ..... | − 52 | 1 | ..... | 2.83 | ..... | .11 | ..... |
| Blaine | 5,660 | − 11,382 | 23 | 24 | 9.13 | 14.36 | 5.42 | 8.25 |
| Boise | 17,376 | + 5,932 | 12 | 8 | 6.79 | 5.21 | 6.71 | 5.16 |
| Bonner | 98 | − 129 | 6 | 10 | 42.94 | 49.06 | 38.38 | 43.32 |
| Cassia | 19 | − 25 | 1 | 1 | 59.68 | 45.63 | 33.82 | 20.84 |
| Clearwater | ..... | − 12 | 1 | ..... | 11.75 | ..... | 11.75 | ..... |
| Custer | 12,988 | + 3,015 | 8 | 11 | 15.26 | 24.93 | 3.47 | 8.52 |
| Elmore | 40,007 | + 5,706 | 12 | 9 | 5.43 | 6.11 | 5.43 | 6.11 |
| Fremont | 71 | − 486 | 1 | 1 | 52.17 | 52.24 | 2.14 | 2.59 |
| Idaho | 7,147 | + 796 | 20 | 24 | 7.30 | 7.93 | 7.30 | 7.93 |
| Kootenai | 19 | + 19 | ..... | 1 | ..... | 22.63 | ..... | 18.00 |
| Latah | ..... | − 66 | 2 | ..... | 12.16 | ..... | .30 | ..... |
| Lemhi | 35,065 | + 19,673 | 22 | 18 | 27.69 | 31.31 | 8.58 | 8.29 |
| Owyhee | 47,401 | − 2,896 | 11 | 7 | 11.38 | 10.02 | 11.38 | 10.02 |
| Shoshone | 2,004,487 | +364,706 | 25 | 34 | 8.78 | 8.13 | 2.24 | 1.99 |
| Total | 2,170,897 | +384,723 | 155 | 152 | 8.99 | 8.61 | 2.70 | 2.45 |

[a] Value per ton, placer product excluded.

*Number of producing mines, classified by chief products, in Idaho in 1911, by counties.*

| County. | Placer mines. | | | Deep mines. | | | | | | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hydraulic. | Dredge. | Drift. | Gold. | Silver. | Gold, silver. | Gold, silver, copper. | Gold-silver-copper-lead. | Gold, silver, lead. | Gold, silver, copper, lead, zinc. | Gold, silver, lead, zinc. | Silver, lead. | Silver, copper, lead. | Silver-lead-zinc. | |
| Ada | 9 | .... | .... | .... | .... | 2 | .... | .... | .... | .... | .... | .... | .... | .... | 11 |
| Adams | 2 | .... | .... | .... | .... | .... | 2 | .... | .... | .... | .... | .... | .... | .... | 4 |
| Bingham | 6 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 6 |
| Blaine | 1 | .... | .... | .... | .... | 3 | 1 | 9 | 8 | .... | .... | 3 | .... | .... | 25 |
| Boise | 46 | 3 | .... | .... | .... | 5 | 2 | .... | 1 | .... | .... | .... | .... | .... | 57 |
| Bonner | 1 | .... | .... | .... | .... | 1 | 1 | 2 | .... | .... | .... | 4 | 2 | .... | 11 |
| Bonneville | 3 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 3 |
| Canyon | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 |
| Cassia | 2 | .... | .... | .... | .... | .... | .... | .... | 1 | .... | .... | .... | .... | .... | 3 |
| Clearwater | 19 | 2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 21 |
| Custer | 9 | .... | .... | .... | .... | 2 | 3 | 1 | 2 | .... | .... | 2 | 1 | .... | 20 |
| Elmore | 13 | .... | .... | .... | 1 | 7 | .... | .... | 1 | .... | .... | .... | .... | .... | 22 |
| Fremont | 1 | .... | .... | .... | .... | .... | .... | .... | 1 | .... | .... | .... | .... | .... | 2 |
| Idaho | 37 | .... | 4 | 2 | .... | 21 | 1 | .... | .... | .... | .... | .... | .... | .... | 65 |
| Kootenai | 2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | 3 |
| Latah | 4 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4 |
| Lemhi | 11 | 2 | 1 | .... | 1 | 8 | 1 | 7 | .... | .... | .... | 1 | .... | .... | 32 |
| Lincoln | 2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 2 |
| Oneida | 4 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4 |
| Owyhee | 5 | .... | .... | .... | .... | 6 | .... | .... | 1 | .... | .... | .... | .... | .... | 12 |
| Shoshone | 15 | .... | 1 | .... | .... | 1 | 3 | 16 | 4 | 3 | 3 | 2 | 1 | 1 | 50 |
| Twin Falls | 10 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 10 |
| Washington | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 |
| Total | 204 | 7 | 6 | 2 | 2 | 56 | 14 | 35 | 19 | 3 | 3 | 12 | 5 | 1 | 369 |

Of the placer mines of Idaho—217 in number—204 were worked by hydraulicking or sluicing, 6 by drift, and 7 by dredge. The deep mines were classified as follows: Gold, 2; silver, 2; gold-silver, 56; gold-silver-copper, 14; gold-silver-copper-lead, 35; gold-silver-lead, 19; gold-silver-copper-lead-zinc, 3; gold-silver-lead-zinc, 3; silver-lead, 12; silver-copper-lead, 5; and silver-lead-zinc, 1—152 in all.

## REVIEW BY COUNTIES.

### ADA COUNTY.

The total production of Ada County was valued at $2,947 in 1911, an increase of $1,370, from 9 placers and 2 deep mines. The greater part of this was placer gold from points along Boise River, and part was mill bullion from Black Hornet, Shaw Mountain, and Neal districts.

### ADAMS COUNTY.

In 1911 the northern half of Washington County was given the name of Adams. The new county yielded 518 tons of ore, $1,066 in gold, 988 ounces of silver, and 132,966 pounds of copper, in all valued at $18,211, or an average of $33.72 per ton. This production represented a slight placer output and copper ore from mines near Landore.

*Seven Devils district.*—Development work and production were confined to the Blue Jacket group and the Arkansaw mine of the Seven Devils Copper Co. The ore of the former is reported to assay about 27 per cent copper and of the latter 7 per cent. Operations of these properties is handicapped by a long wagon haul from Landore to the shipping point at Homestead, Oreg. The district product is largely oxidized ore in a siliceous gangue.

*Unorganized district.*—On Little Goose Creek, 4 miles east of Meadows, gold was sluiced from the Rock Flat placer.

### BINGHAM COUNTY.

Bingham County, reduced to half its former size by the creation of Bonneville County, retains placers along Snake River, but loses the Mount Pisgah district.

*Snake River district.*—At Yuma, Aberdeen, and Blackfoot, $1,651 in gold was taken from bars along the stream by 6 operators.

### BLAINE COUNTY.[1]

*Mine production of gold, silver, copper, lead, and zinc in Blaine County, Idaho, in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| DEEP MINES. | | | | | | |
| Gold.....fine ounces.. | 2,047.95 | $42,335 | 1,031.89 | $21,331 | −1,016.06 | −$21,004 |
| Silver.....do.... | 92,596 | 50,002 | 47,837 | 25,354 | − 43,759 | − 24,648 |
| Copper.....pounds.. | 20,018 | 2,542 | 9,359 | 1,170 | − 10,659 | − 1,372 |
| Lead.....do.... | 1,284,966 | 56,539 | 705,545 | 31,750 | − 579,421 | − 24,789 |
| Zinc.....do.... | 76,397 | 4,125 | 29,814 | 1,699 | − 46,583 | − 2,426 |
| PLACERS. | | | | | | |
| Gold.....fine ounces.. | ..... | ..... | 11.66 | 241 | + 11.66 | + 241 |
| Silver.....do.... | ..... | ..... | 2 | 1 | + 2 | + 1 |
| Total..... | ..... | 155,543 | ..... | 81,546 | ..... | − 73,997 |

[1] Lakes, Arthur, The Wood River mining district of Idaho: Min. World, Feb. 4, 1911, p. 307.

*Source of gold and silver in Blaine County, Idaho, in 1910 and 1911, by kinds of ore, in fine ounces.*

| Metal. | Year. | Placers. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|---|
| Gold | 1910 | ..... | 1,654.01 | ..... | 367.01 | 26.93 | ..... | 2,047.95 |
| | 1911 | 11.66 | 920.33 | ..... | 110.21 | ..... | 1.35 | 1,043.55 |
| Silver | 1910 | ..... | 4,904 | ..... | 87,198 | 494 | ..... | 92,596 |
| | 1911 | 2 | 4,396 | ..... | 43,110 | ..... | 331 | 47,839 |

Blaine County, steadily decreasing its output in the last seven years, had decreases in production of all metals for 1911. There were 24 deep mines which produced 5,660 tons of ore, including 1,890 tons of old tailings. Of this ore tonnage, 2,658 tons were siliceous, 2,871 tons lead ore, and 131 tons lead-zinc ore. Nearly half the ore, or 2,541 tons, was treated in gold and silver mills, and $16,866, or $6.64 per ton, recovered in gold and silver bullion. Of this product, 578.06 ounces of gold and 301 ounces of silver came from amalgamation and the remainder was won by cyanidation. From 462 tons of ore and 1,890 tons of tailings, 340 tons of concentrates were made, having a total value of $14,699, or $43.23 per ton. The remainder was 767 tons of crude ore shipped to smelter, having a value of $64.85 per ton.

*Dome district.*—From the Wilbert[1] mine, 25 miles northeast of Arco, no shipments were made, but construction was begun on a concentration plant of a daily capacity of 150 tons. This mill is to have a crusher, rolls, Hartz jigs, Wilfley tables, slimers, Janny classifier, and Hardinge mill.

*Hamilton district.*—Lead ore was marketed from the Badger Creek and Metta mines, near Howe. The latter produces a sulphide ore with some zinc.

*Lava Creek district.*—A trial shipment of lead ore, rich in silver, was made from the Iron Mountain mine.

*Little Wood River district.*—The Muldoon mine was practically idle, but a few tons of concentrate were smelted.

*Mineral Hill district.*—From 16 deep mines, 2,871 tons of ore, mainly galena, was shipped or treated, containing $6,904 in gold, 28,640 ounces of silver, 3,669 pounds of copper, 412,864 pounds of lead, and 29,814 pounds of zinc, in all valued at $42,820, or $14.92 per ton. An unusually dull season was experienced in the district. The Minnie Moore mine was unproductive, and the Crœsus, Eureka, Jay Gould, and Red Cloud were only slightly productive. Half the lead output of the district was mined at the Nay Aug and Singleterry vein. A shipment of partly oxidized ore, carrying nearly an ounce of gold to the ton, was taken from the Golden Bell mine.

*Skeleton Creek district.*—The El Oro Milling & Mining Co. operated a 10-stamp mill intermittently on a gold and silver ore, which is both oxidized and a sulphide, from the Frazier mine, near Soldier. Bullion and concentrates were sold. The Oregon Short Line will construct a branch line from Richfield, in Lincoln County, to Soldier, in Blaine County.

*Soldier district.*—The Old Sam mine was practically idle. This region and eastern Elmore County will be benefited by the advent of the railroad.

[1] Min. and Sci. Press, Jan. 13, 1912, p. 116.

*Warm Springs district.*—The main work was done on the Trapper and Ophir property by the Golden Glow Mining Co., and on the Starlight property by the Pulaski Mineral Co. The former company has a small concentrating plant consisting of crusher, rolls, and jig. The ore is sulphide in character.

## BOISE COUNTY.

*Mine production of gold, silver, copper, and lead in Boise County, Idaho, in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| DEEP MINES. | | | | | | |
| Gold.....fine ounces.. | 3,374.97 | $69,767 | 4,242.34 | $87,697 | + 867.37 | +$17,930 |
| Silver.....do.... | 13,010 | 7,025 | 3,736 | 1,980 | − 9,274 | − 5,045 |
| Copper.....pounds.. | 5,957 | 757 | 5,354 | 669 | − 603 | − 88 |
| Lead.....do.... | 3,001 | 132 | 2,773 | 125 | − 228 | − 7 |
| PLACERS. | | | | | | |
| Gold.....fine ounces.. | 6,272.45 | 129,663 | 12,856.48 | 265,767 | +6,584.03 | +136,104 |
| Silver.....do.... | 1,433 | 773 | 3,572 | 1,893 | + 2,139 | + 1,120 |
| Total..... | ..... | 208,117 | ..... | 358,131 | ..... | +150,014 |

*Source of gold and silver in Boise County, Idaho, in 1910 and 1911, by kinds of ore, in fine ounces.*

| Metal. | Year. | Placers. | Dry or siliceous ore. | Total. |
|---|---|---|---|---|
| Gold..... | 1910 | 6,272.45 | 3,374.97 | 9,647.42 |
| | 1911 | 12,856.48 | 4,242.34 | 17,098.82 |
| Silver..... | 1910 | 1,433 | 13,010 | 14,443 |
| | 1911 | 3,572 | 3,736 | 7,308 |

Production of gold increased slightly from 8 deep mines and materially from 49 placers. The deep mines produced 17,376 tons of ore, valued at $90,471, or $5.21 per ton. The greater part of this ore—14,837 tons—went to gold and silver mills, and bullion therefrom was valued at $71,881, or $4.84 per ton. Of this bullion, 273.57 ounces of gold and 212 ounces of silver were recovered by cyanidation, and the remainder, or greater part, by amalgamation. Of the total ore produced, 2,340 tons were concentrated and reduced to 814 tons of concentrates; and 199 tons were shipped crude and had a value of $43.76 per ton. The ore occurs in veins in granite. The placer output, greatly increased through dredging, had a total value of $267,660.

*Boise Basin region.*—Four deep mines and 39 placers produced gold valued at $328,838, 4,607 ounces of silver, and 796 pounds of copper, valued in all at $331,380. All the ore, or 14,785 tons, valued at $4.40 per ton, went to gold and silver mills, and contained 3,062.46 ounces of gold and 834 ounces of silver in bullion and a few tons of concentrates. The deep mines were the Golden Age, Gold Hill and Iowa, and Mayflower. The principal placers were the Boston and Idaho, Basin Branch, Harwood Glen, Moline, Leary, Crevice Diggings, Oaks, and Globe. Three dredges were operated in the district, 1 by the

Moline Mining Co. and 2 by the Boston & Idaho Co. The Moline plant, of the Risdon type, was operated by steam and had a bucket capacity of 5 cubic feet and is rated at between 1,100 and 1,400 cubic yards per day. The old dredge of the Boston & Idaho Co. was operated the entire year, even during the winter months. It is rated at 2,000 cubic yards per day, has 5-cubic-foot buckets, and is run by electricity. The construction of the large boat of this company was completed and operations were begun in the summer. It has 13½-cubic-foot close connected buckets, an 84-foot digging ladder to dig 25 feet below water line, 110-foot belt conveyers, 4 motors giving 300 horsepower, and a rated capacity of 300,000 cubic yards per month. The ground to be worked is reported to be 22 feet to bedrock, several hundred feet wide, and about 6 miles long, and the gravel to average 10 to 20 cents per cubic yard.

*Deadwood Basin District.*—Production consisted of placer gold, and bullion from the Merry Blue mine, the ore of which is oxidized.

*Hay Fork district.*—The Switzerland mine was productive of some rich free gold ore treated in arrastre.

*Payette River district.*—Small placers in Payette River district yielded $366 in gold and 5 ounces of silver.

*West View district.*—Operations were confined to work at the Whitman property, with the exception of a little placer gold and a shipment from the Friday mine. From the Leviathan group of the Whitman Mining Co. the products were concentrates, first-class shipping ore, and cyanide precipitates. The ore is sulphide with a siliceous gangue. The company owns a 50-ton concentration plant, and formerly crude ore and concentrates were marketed, but in 1911 experiments were made at the Black Pearl plant, whereby the concentrates were cyanided. The property was idle the latter half of the year.

### BONNER COUNTY.

The output of all metals in Bonner County continued to decrease. The production was 98 tons of ore containing $180 in gold, 7,748 ounces of silver, 2,045 pounds of copper, and 6,822 pounds of lead, valued in all at $4,849. This is a decrease in total value of $4,899. The ore, valued at $49.06 per ton, was a first-class product shipped to smelters, 70 tons being siliceous and 28 tons lead ore.

*Lake View district.*—Small shipments were made from the Idaho Queen, Hidden Treasure, Fall Creek, and Rainbow properties valued at $862.

*Pend Oreille district.*—From 6 properties small shipments were made to Tacoma and East Helena smelters, since the smelting plant at Ponderay has not been reopened. The ore was valued at $3,946, or $66.88 per ton, most of which was the value of the silver. The B. F. and H. and the Blue Bird were the largest producers

*Priest Lake district.*—In the extreme northern part of the State, the Idaho Continental mine is reported to have a large body of lead ore awaiting concentration and transportation to Port Hill on the Great Northern.

### BONNEVILLE COUNTY.

Bonneville County, as separated from Bingham, includes part of Snake River, and the Mount Pisgah district, near Gray. The output was all placer product valued at $2,860 for gold, with 5 ounces of

silver. The American placer was again productive of fine gold from Carriboo Mountain, 15 miles from Gray.

### CANYON COUNTY.

*Boise River district.*—The output of this district and county was confined to a small placer product.

### CASSIA COUNTY.

Production of Cassia County decreased and consisted in placer gold from Snake River and lead ore from the Alice mine in the Stokes district.

### CLEARWATER COUNTY.

Clearwater County, established in 1911, consists of the eastern part of old Nez Perce County, which includes the main mining region. The output was entirely that of 21 placers—$40,756 in gold and 523 ounces of silver, a very slight increase over the production of 1910.

*Burnt Creek district.*—From 5 small placers $1,114 in gold and 13 ounces of silver were produced.

*Pierce district.*—From 16 placers gold valued at $39,642 and 510 ounces of silver were produced, mostly by dredges. The Idaho Co. (Ltd.) owns two dredges in the district. The old dredge, which has 3¼ cubic-foot buckets and is operated by electricity, was in use most of the year, having been leased to the Sprague Co. It treats 1,500 cubic yards of gravel per day. The newer dredge, which has 3¾ cubic-foot buckets and is operated by electricity, was run only a short time in the early part of the year. Other placer properties in the district were only slightly productive.

### CUSTER COUNTY.

The county produced 12,988 tons of ore, $89,861 in gold, 52,633 ounces of silver, 1,685,224 pounds of copper, 54,252 pounds of lead, valued in all at $330,850. The increases in output of all metals aggregated in value $173,273. There were 11 deep mines and 9 placers. The placers produced $7,021 in gold and 135 ounces of silver. Only 203 tons of ore were treated by amalgamation, and the remainder was shipped crude to smelters and was valued at $322,427, or $25.22 per ton. Most of the gold and silver and all of the copper came from copper ore.

*Alder Creek district.*[1]—The Empire Copper Co., through lessees, operated the White Knob mine and has made the property the largest producer in the county and an important copper mine of the State. From May to October 155 cars of ore, having an average value of $19.22 per ton, had been shipped to Salt Lake, and considerably over 1,000,000 pounds of copper marketed. The ore, which is a mixture of oxidized and sulphide ores, in a basic gangue assayed about 6 per cent copper. The old smelting plant connected with the mine was idle. The Homestake and the Tiger, in the same district, produced small shipments of ore.

[1] Weed, W. H., The copper mines of the United States in 1905: Bull. U. S. Geol. Survey No. 285, 1906, p. 108.

*Bay Horse district.*—From 5 deep mines and 1 placer the district produced 38 tons of ore, $72 in gold, 3,405 ounces of silver, 636 pounds of copper, 43,432 pounds of lead, in all valued at $3,910, or $101.15 per ton. The ore is principally galena.

*Loon Creek district.*[1]—Production consisted of a slight amount of placer gold and matte from the smelter of Lost Packer copper mine. Two runs of 10 days each were made at the matting plant and 84 tons of ore were treated per day. There were 300 tons of matte shipped, reported to be valued at nearly $100,000. The ore is rich in both gold and copper. Coke is hauled 125 miles by wagon from the nearest railroad station.

*Stanley Basin district.*—From 5 placers $6,294 in gold and 129 ounces of silver were produced. No dredge was operated and the Joe's Gulch was the largest producer.

*Yankee Fork district.*—A comparatively small production consisted of $1,820 in gold and 58 ounces of silver. The decrease was due to the idleness of the Golden Sunbeam mine. The mill was only operated slightly in May and June, and the affairs of the company were in the hands of a receiver. The new power plant was also idle.

### ELMORE COUNTY.

The production of the county was $238,287 in gold, 18,412 ounces of silver, and 4,100 pounds of lead, valued in all at $248,230, an increase of $58,845, largely in gold. The placer product amounted to $3,570. The ore—40,007 tons in quantity—was all siliceous and had a gold and silver value of $6.11 per ton. By amalgamation, 5,551.59 ounces of gold and 6,344 ounces of silver were recovered, and by cyanidation 4,755.04 ounces of gold and 10,474 ounces of silver. From this ore treated in gold and silver mills 359 tons of concentrates were also produced, valued at $22,415, or $62.44 per ton.

*Bear Creek district.*—Two deep mines and 5 placers had small productions amounting in all to $1,748 in gold and 35 ounces of silver. The 5-stamp mill at the Bonaparte mine was active a short time and some placer claims on Feather River were worked by hydraulicking.

*Black Warrior district.*—A few tons of ore from 2 prospects were crushed in a mortar.

*Middle Boise district.*—Formerly this was the most important district of the county, but in 1911 the Bagdad Chase and Atlanta mines were practically idle, so that Neal district took first place. The Minerva mine produced bullion from a 20-stamp mill from January to October. Since the ore is oxidized, most of the gold is won by amalgamation, and the concentrates are cyanided. The ore of the district occurs in veins in granite cut by quartz-porphyry.

*Neal district.*—A considerable production was made at the Roth property, including the Homestake, Daisy, and Hidden Treasure mines. The 10-stamp mill was active throughout the year, and 3 Pachuca tanks and new plates were added. The ore is stamped and amalgamated, the pulp is separated into sands and slimes, and the slimes are cyanided, while the sands are concentrated and cyanided by special process. The ore is pyrite in partly decomposed granite. Previously concentrates were smelted.

[1] Umpleby, J. B., A preliminary account of the ore deposits of the Loon Creek district, Idaho: Bull. U. S. Geol. Survey No. 530, 1912.

*Pine Grove district.*—Some bullion was shipped from the Franklin mine, but comparatively little work was done at this property. There was also a small placer output from the district.

*Twin Springs district.*—On the Elmore County side of the Boise River, $1,831 in gold and 27 ounces of silver came from placer mining.

### FREMONT COUNTY.

Fremont County supplied a small amount of first-class oxidized lead ore from the Scott mine.

### IDAHO COUNTY.

*Mine production of gold, silver, and copper in Idaho County, Idaho, in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| DEEP MINES. | | | | | | |
| Gold.....fine ounces.. | 2,201.89 | $45,517 | 2,710.49 | $56,031 | +508.60 | +$10,514 |
| Silver.....do.... | 1,588 | 858 | 1,163 | 616 | − 425 | − 242 |
| Copper.....pounds.. | ..... | ..... | 312 | 39 | + 312 | + 39 |
| PLACERS. | | | | | | |
| Gold.....fine ounces.. | 888.55 | 18,368 | 931.95 | 19,265 | + 43.40 | + 897 |
| Silver.....do.... | 156 | 84 | 175 | 93 | + 19 | + 9 |
| Total..... | ..... | 64,827 | ..... | 76,044 | ..... | + 11,217 |

The total value of the gold and silver output of this county, a large producer in former years, was only $76,044, an increase of $11,217. To make this total, 24 deep mines and 41 placers were operated, giving a small average output for each mine. There were 7,147 tons of ore mined, of which only 22 tons were shipped. The remainder, 7,125 tons, was treated by amalgamation, and bullion valued at $56,235, or $7.89 per ton, was recovered.

*Big Creek district.*—The Moscow mine was, as formerly, the source of gold ore treated in a 5-stamp mill. The Eagle Mining Co., with office at Edwardsburg, completed a 25-ton mill equipped for concentration and cyanidation. This plant of 2 Tremain stamps made a trial run in the fall and some concentrates were stored. These were not shipped.

*Camp Howard district.*—A small placer product came from this district, and similar outputs from Clearwater, Crooks Corral, Dixie, and Florence districts.

*Elk City district.*—From 5 placers and 5 deep mines, the district production was $39,476 in gold, 524 ounces of silver, and 312 pounds of copper, in all valued at $39,792, or $9.34 per ton. Ore of the district occurs in veins in gneiss cut by granite. Of the ore, 4,046 tons went to gold and silver mills with a recovery of 1,813.14 ounces of gold and 480 ounces of silver, and 22 tons were shipped to smelters. The Buster mine, a large producer in 1909, remained idle. The only output of note came from the South Fork mine, where a 5-stamp mill

was active for 300 days on oxidized ore averaging about $10 on the plates. Other producing deep mines were the Deer Creek, Grangeville, and Little Butte. At the close of the year, a custom milling plant was completed for this region. It is equipped for amalgation, concentration, and cyanidation. Two dredges in the district were idle.

*Florence district.*—The Buttercup and Old Town placers were productive in a small way.

*Newsome district.*—Three deep mines and 2 placers produced $2,311 in gold and 30 ounces of silver. The productive placers were on Moose Creek and Newsome and Leggett Creek. A 2-stamp Hammond mill on the Little Giant and a 10-ton Kinkead mill on the Iron Crown supplied bullion.

*Orogrande district.*—The Idaho-Champion property is considerably developed and has a 10-stamp mill equipped for amalgamation and concentration. Five stamps were in operation several months, largely for the purpose of testing the ore, which is somewhat difficult to treat.

*Robbins district.*—The Jumbo mine was leased several times during the year, and was productive of bullion through the operation of 10 of the 24 stamps of the mill. The ore, which contains gold and silver, is a sulphide.

*Simpson district.*—From 7 placers near Lucile, gold valued at $1,781 and 11 ounces of silver were marketed.

*Ten Mile district.*—Four placers and one deep mine, near Golden, supplied gold valued at $3,197 and 42 ounces of silver. A short run was made at the Buckhorn mine, which was equipped with a small amalgamation mill. The active placers were the Alpine Bar, None Such, Good Enough, and Tippie.

*Thunder Mountain district.*—Placer and mill bullion containing $5,160 in gold and 154 ounces of silver was marketed. Ore from the old dumps at the Dewey mine was run over amalgamation plates. The ore of the locality occurs in veins and impregnations.

*Warren district.*—From 6 small deep mines and 8 placers, the production was $11,891 in gold and 359 ounces of silver. By amalgamation, 235 tons of oxidized ore were treated. The Golden Rule Co. mined most of the placer gold, and the Confidence and White Monument supplied most of the mill bullion. On the former there is a 20-ton roll mill and on the latter a 3-stamp amalgamation mill.

### KOOTENAI COUNTY.

The total value of the output from this county was $11,226, derived from a trial shipment of ore from Hayden Lake district and placer gold from Camas Cove district. The Cedar Creek Mining Co. operated for 6 months at Tyson and produced much fine gold.

### LATAH COUNTY.

Placer product valued at $956 was recovered from Bald Mountain, Gold Creek, and Hoodoo districts.

## LEMHI COUNTY.

*Mine production of gold, silver, copper, and lead in Lemhi County, Idaho, in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| DEEP MINES. | | | | | | |
| Gold.....fine ounces.. | 2,466.26 | $50,982 | 4,240.84 | $87,666 | + 1,774.58 | +$36,684 |
| Silver.....do.... | 150,119 | 81,064 | 382,904 | 202,939 | + 232,785 | +121,875 |
| Copper.....pounds.. | 54,887 | 6,971 | 390,660 | 48,832 | + 335,773 | + 41,861 |
| Lead.....do.... | 6,526,474 | 287,165 | 16,854,922 | 758,471 | +10,328,448 | +471,306 |
| PLACERS. | | | | | | |
| Gold.....fine ounces.. | 772.98 | 15,979 | 1,621.68 | 33,523 | + 848.70 | + 17,544 |
| Silver.....do.... | 66 | 36 | 135 | 72 | + 69 | + 36 |
| Total..... | ..... | 442,197 | ..... | 1,131,503 | ..... | +689,306 |

*Source of gold and silver in Lemhi County, Idaho, in 1910 and 1911, by kinds of ore, in fine ounces.*

| Metal. | Year. | Placers. | Dry or siliceous ore. | Copper ore. | Lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|
| Gold..... | 1910 | 772.98 | 2,189.19 | ..... | 277.07 | ..... | 3,239.24 |
| | 1911 | 1,621.68 | 3,161.72 | 359.59 | 719.53 | ..... | 5,862.52 |
| Silver..... | 1910 | 66 | 355 | ..... | 149,764 | ..... | 150,185 |
| | 1911 | 135 | 3,877 | 2,568 | 376,459 | ..... | 383,039 |

Production of Lemhi County in 1911 shows large increases in all metals, from both deep and placer mines. The greatest increase was in the output of lead, with silver, gold, and copper following. The placer product, valued at $33,595, came from 14 mines, 2 of which were operated by dredges. From 18 producing deep mines there was an output of 35,065 tons of ore, valued at $31.31 per ton. This was an increase of 19,673 tons, or over 56 per cent, over the production of 1910. The output of lead ore, in which there was the greatest increase, was over 77 per cent of the total. Owyhee County held second place in the production of silver in Idaho for many years, but Lemhi County has taken second place in the production of both silver and lead. Over 79 per cent of the ore produced, or 27,839 tons, was shipped to smelters and was valued at $1,036,766, or $37.24 per ton. Twenty per cent of the ore—7,226 tons—was treated in gold and silver mills, and bullion valued at $55,638 was recovered, or $7.70 per ton. The production by cyanidation was valued at $2,954, and the remainder was recovered by amalgamation.

*Blue Wing district.*—Work was done on tungsten deposits on Patterson Creek. The property is partly developed and some of the ore was concentrated.

*Carmen Creek district.*—At the Oro Cache mine work was done preparatory to operating in 1912. The 10-stamp mill is equipped for amalgamation and concentration.

*Eldorado district.*—A considerable gold output was taken from the Bohannon Bar placer by hydraulicking.

*Eureka district.*—The Mullen dredge, on Moose Creek, was operated four and one-half months. The plant is run by steam and has buckets holding 5 cubic feet of gravel each.

*Gibbonsville district.*—Gold valued at $11,868 and 108 ounces of silver came from this region. The greater part of this output was from bullion of the American D. M. & R. Co.'s property. A 15-stamp mill, equipped for amalgamation, concentration, and cyanidation, ran intermittently from April to November on sulphide ore. The district ore occurs in veins.

*Indian Creek district.*—The largest gold producer of the county was the Kittie Burton, at Ulysses. Concentrate and bullion were marketed from May to December through the operation of the 15-stamp mill. The ore is sulphide in a siliceous gangue. A pipe line 5,300 feet long was constructed and improvements were made to permit operations the entire year.

*Junction district.*—This district produced 465 tons of ore—$62 in gold, 10,250 ounces of silver, 409 pounds of copper, and 213,831 pounds of lead, in all valued at $15,168, or $32.62 per ton. The Leadville group and the Iowa mine produced lead ore, and the Commodore Mining Co. made its initial shipment of rich silver ore.

*Kirtley Creek district.*—Six miles east of Salmon, on Kirtley Creek, a new dredge was constructed during the year and operated in November and December. The plant has close-connected buckets, each having a capacity of 9 cubic feet, a digging ladder 84 feet long to dig 25 feet below water line, with a 110-foot belt conveyor. The plant is driven by 4 motors, giving 250 horsepower, and has a total rated capacity of 150,000 cubic yards per month.

*Leesburg district.*—Gold was washed from the Richardson placer.

*Mackinaw district.*—At the Italian property work consisted in completing a power plant and a 30-stamp amalgamation and concentration mill. Although part of the plant was in use in September on an oxidized ore, little bullion was sold.

*Mineral Hill district.*—At Shoup a few tons of oxidized ore were treated in an arrastre at the Panata group.

*Salmon City district.*—The Red Cross group, opened by tunnel, was the source of lead ore containing considerable gold.

*Texas district.*—From 4 deep mines the district produced 26,862 tons of partly oxidized ore, $18,778 in gold, 369,526 ounces of silver, 109,754 pounds of copper, and 16,609,921 pounds of lead, in all, valued at $975,793, or $36.33 per ton. This is the largest output the district has ever produced. The Pittsburg-Idaho, Latest Out, Allie, and Silver Fissure mines produced ore that was shipped over the spur from Gilmore to Leadore. Shipments from the Gilmore mine of the Pittsburg-Idaho Co. were greatly increased, to nearly 2,000 tons per month. Dividends were paid amounting to $56,350. Limonite containing gold and silver was shipped by the Allie Co. Ore containing about 33 per cent lead was being shipped from the Latest Out mine at the rate of 600 tons per month. All the ore of the district is shipped without concentration and occurs in veins and replacements.

*Yellow Jacket district.*—The old Yellow Jacket mine was worked to reopen old tunnels, but the 60-stamp mill was idle.

*Unorganized district.*—Near Tendoy, on Agency Creek, a good production of rich sulphide copper ore containing much gold was

shipped from the Copper Queen mine. One lot of lead ore was taken from the Black Friday property.

### LINCOLN COUNTY.

A few ounces of placer gold were sluiced from points on Snake River in Lincoln County.

### ONEIDA COUNTY.

Only $255 in gold came from placers near Neely and American Falls in Oneida County.

### OWYHEE COUNTY.

Owyhee County, which has taken second place in both gold and silver production, yielded $322,203 in gold and 291,133 ounces of silver, which, with a small quantity of lead, gave a total value of $476,578. Since the closing of the Trade Dollar mine, production has greatly decreased in the State. All of the ore, 47,401 tons, was siliceous and was valued at $10.02 per ton. With the exception of 1 ton of ore shipped, the tonnage was treated at gold and silver mills, 4,967 tons being old tailings re-treated. Bullion produced was valued at $451,460, or $10.64 per ton, and bullion recovered by amalgamation contained 647.96 ounces of gold and 4,903 ounces of silver, and production by cyanidation was 14,578.12 ounces of gold and 253,039 ounces of silver. Ore treated by amalgamation aggregated 871 tons and 46,529 tons of ore and tailings were cyanided.

*Carson district.*—The main district of the county at Silver City and De Lamar produced from 6 deep mines and 1 placer gold valued at $321,810 and 289,885 ounces of silver. The output of ore aggregated 47,310 tons, valued at $10.03 per ton; the ore was both sulphite and oxidized. The mine and the 150-ton cyanide plant of the De Lamar[1] Co. were operated the entire year. The property was said to have been operated at a low margin of profit, due in part to large expense in timbering.[2] The Trade Dollar was only slightly productive through lessees. The Banner Mine & Mining Co. has a mill consisting of 4 Nissen stamps, but the plant was only run in an experimental way. The Bergh Mining Co. operated a 5-stamp amalgamation and concentration mill from May until October. Small bullion shipments were also made from the Burro and Jap and Neversweat.

*Castle Creek district.*—The Golden Crown Mining Co. treated an oxidized ore in a new 15-ton cyanide plant.

*Snake River and Steel districts.*—A small placer output was taken from each district.

---

[1] Some gold deposits of the Northwest: Eng. and Min. Jour., Aug. 26, 1911, p. 408.
[2] Conservation in Idaho: Eng. and Min. Jour., Nov. 18, 1911, p. 984.

## SHOSHONE COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Shoshone County, Idaho, in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (—). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| DEEP MINES. | | | | | | |
| Gold.....fine ounces.. | 2,711.85 | $56,059 | 3,647.28 | $75,396 | + 935.43 | + $19,337 |
| Silver.....do.... | 6,703,005 | 3,619,623 | 7,383,796 | 3,913,412 | + 680,791 | + 293,789 |
| Copper.....pounds.. | 6,018,688 | 764,373 | 2,926,551 | 365,819 | — 3,092,137 | — 398,554 |
| Lead.....do.... | 219,758,042 | 9,669,354 | 254,837,009 | 11,467,665 | + 35,078,967 | +1,798,311 |
| Zinc.....do.... | 5,526,717 | 298,443 | 8,310,435 | 473,695 | + 2,783,718 | + 175,252 |
| PLACERS. | | | | | | |
| Gold.....fine ounces.. | 436.20 | 9,017 | 514.66 | 10,639 | + 78.46 | + 1,622 |
| Silver.....do.... | 75 | 41 | 103 | 54 | + 28 | + 13 |
| Total..... | ..... | 14,416,910 | ..... | 16,306,680 | ..... | +1,889,770 |

*Source of gold and silver in Shoshone County, Idaho, in 1910 and 1911, by kinds of ore, in fine ounces.*

| Metal. | Year. | Placers. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|---|
| Gold..... | 1910 | 436.20 | ..... | 492.13 | 2,219.72 | ..... | ..... | 3,148.05 |
| | 1911 | 514.66 | 23.78 | 172.96 | 2,998.14 | 7.74 | 444.66 | 4,161.94 |
| Silver..... | 1910 | 75 | ..... | 446,471 | 6,238,518 | 18,016 | ..... | 6,703,080 |
| | 1911 | 103 | 2,409 | 201,758 | 6,635,624 | 33,669 | 510,336 | 7,383,899 |

The output of Shoshone County, or the Cœur d'Alene region, showed considerable increases in all metals but copper, the increase in lead being notable. The value of the county output was 85 per cent of the total value of the State output. There were 50 productive mines, of which 16 were placers. From 34 deep mines 2,004,487 tons of ore were produced, which had a value per ton of $8.13. Nearly 77 per cent was a lead product, nearly 20 per cent lead-zinc ore, and the remainder copper ore and zinc ore. Only a few tons of ore were treated at an amalgamation mill. The greatest part, 1,817,917 tons of ore and 91,928 tons of old tailings was concentrated, making 220,935 tons of concentrates, valued at $12,497,180, or $56.56 per ton. Crude ore shipped amounted to 94,592 tons, valued at $3,798,326, or $40.15 per ton. With the exception of the copper ore, which was partly oxidized, the entire tonnage was a sulphide ore in a siliceous gangue, occurring in veins in pre-Cambrian sediments.[1] The zinc ore amounted to 51,050 tons, of which 50 tons were shipped without treatment and the remainder was concentrated on tables and shipped east. The lead-zinc ore—397,223 tons—represented 131 tons shipped direct to smelters and the remainder reduced by tables and Macquisten tubes to a zinc concentrate and a lead concentrate. Copper ore aggregating 26,349 tons was shipped without treatment

[1] Ransome, F. L., and Calkins, F. C., The geology and ore deposis of the Cœur d'Alene district, Idaho: Prof. Paper U. S. Geol. Survey No. 62, 1908.

to copper and lead smelters to be used as converter lining, since the gangue is highly siliceous. Of the siliceous ore, which aggregated 103 tons, 53 tons were shipped to a copper smelter and 50 tons treated in an amalgamation mill. Lead ore, the predominant product, aggregated 1,529,762 tons. Of this amount, 68,009 tons were shipped direct to lead smelters and the remainder was concentrated.

*Beaver district.*—Nine placers and 2 deep mines produced 141 tons of ore, $6,835 in gold, 3,602 ounces of silver, 156,231 pounds of lead, in all valued at $15,774, or $63.35 per ton. The Gilbert and the Black Hill were the largest placer producers. Lead ore came from the Idora and the Tuscumbia on Sunset Peak, the latter a new shipper.

*Eagle district.*—The output of the district was placer dust from Eagle Creek and rich lead ore from the Jack Waite mine. This mine is a new producer, and the first-class ore contains little silver but about 60 per cent of lead. Ore must be hauled 12 miles to Eagle on the line of the Oregon-Washington Railroad & Navigation Co.

*Evolution district.*—The Nellie mine, near Osburn, was operated through lessees and a few cars of ore rich in silver were sent to the smelter.

*Hunter district.*—Four mines in this district produced 494,376 tons of ore, $19,163 in gold, 1,230,360 ounces of silver, 2,073,724 pounds of copper, 45,879,504 pounds of lead, and 995,656 pounds of zinc, in all valued at $3,051,800, or $6.17 per ton, for the ore before treatment. Of the total ore, 47,892 tons were shipped crude and 446,432 tons concentrated, making 40,616 tons of concentrates. There was a decrease in copper output, but a large increase in lead and zinc. The Morning mine, which was operated at a loss in 1910, was again brought to a paying basis during 1911. Huntington mills were replaced by Hardinge ball mills, and interesting experiments were made with Macquisten tubes,[1] by which a marketable zinc product was separated from a lead-zinc ore. Of these tubes, 119 were in operation in May, treating middlings and tailings from Wilfley tables and the tailings from vanners, containing zinc blende, siderite, and silica. The flotation process separates the zinc sulphide from siderite, making a concentrate containing about 50 per cent zinc. In the latter part of the year the plant was treating 95 tons per day, resulting in 300 tons of concentrate per month. The sorting plant was enlarged to handle the entire product of the mine, and about 6 per cent of the ore mined was shipped without treatment, and the remainder was run through the 1,000-ton concentration mill. According to the statement of the county assessor, there were 384,600 tons extracted during the year, yielding a gross value of $1,776,671. The cost for extraction was $859,557; transportation, $722,443; construction, $79,950; leaving a net profit of $114,721. The Federal Mining & Smelting Co. for this mine and others at Wardner and Mace distributed $840,000 in dividends on the preferred stock. The Alice mine, in Ruddy Gulch, was only operated in January by lessees. Although the Gold Hunter mine was operated at a loss in 1911, there was a record production in both silver and lead, about 900 tons of concentrates having been shipped per month. In No. 6 adit a 3-compartment winze was sunk 200 feet, and ore at this

[1] Scott, W. A., Tube concentrator in Cœur d'Alene: Min. and Sci. Press, Nov. 23, 1911, p. 809.

depth was so improved that many additions were made at both mine and mill. An electric hoist purchased in May permits sinking to a depth of 800 feet below No. 6 level. The county assessor's figures are as follows: Ore extracted, 86,190 tons; gross value, $366,957; cost of extraction, $276,262; transportation, $103,033; construction, $35,480; net loss, $47,818. All ore was concentrated in a 300-ton mill. Shipments of copper ore from the Snow Storm mine were greatly decreased. The company report for the year ending June 30, 1911, gave 34,463 tons, assaying 7.98 ounces of silver and 3.93 per cent copper. The report for the calendar year to the assessor gave 26,202 tons extracted; gross yield, $263,774; cost of extraction, $83,864; transportation, $150,595; construction, $35,547; net loss, $6,232. The ore was shipped to various smelters for converter lining, but since many plants are using basic lining for converters, demand for this class of ore has been less. The old 150-ton leaching plant has been abandoned and a concentrator will be erected.

*Lelande district.*—Seven deep mines produced 495,037 tons of sulphide ore, $23,466 in gold, 3,271,384 ounces of silver, 376,213 pounds of copper, and 84,084,662 pounds of lead, giving a total value of $5,588,137, or $11.29 per ton of ore mined. This is the second largest district output of the State, and its output shows a large increase over that of 1910. Most of the ore, or 465,281 tons, was concentrated and reduced to 60,854 tons of concentrates, and 28,980 tons were sorted and shipped crude. The Federal Mining & Smelting Co. operated no mines at Burke, but the Mace property was second only to the Bunker Hill mine in production. The output had a gross value of $2,029,440 from 225,400 tons of ore, most of which was concentrated. The vertical shaft has a depth of 2,340 feet, and 6,000 feet was done in 1911 in drifts, etc. The cost for extraction was given as $842,288; transportation, $596,260; betterments and repairs, $8,217, and the net profit was $582,675. Lessees took some ore from the Frisco mine, which is under water and not operated by the owners. At the Hecla mine, at Burke, the 300-ton mill and sorting plant were operated throughout the year. Sinking was begun from the 1,200-foot level to the 1,600-foot level. About 1,050 tons of concentrate and 550 tons of sorted crude ore were shipped per month, and 8,000 tons of crude ore were concentrated. The county assessor's figures give a gross tonnage extracted of 136,479 tons, which had a total value of $1,001,344. The cost of extraction was $396,076; transportation, $316,298; repairs, $1,868, and net profit, $287,102. Dividends aggregating $240,000 were declared. The report of the directors stated that at the present rate of production there were sufficient ore reserves to last five years. At the Hercules mine a record production was made, valued at nearly $2,000,000. The new mill,[1] near Wallace, was completed and operations began in April, from 400 to 600 tons of ore being treated per day. At the mouth of No. 4 adit, near Burke, the ore is sorted, a clean shipping product separated, and the mill ore crushed to 2½-inch mesh and taken by 3,500-foot tramway to Burke, whence it is shipped by rail to the Wallace mill and concentrated at a ratio of 8:1. The company now controls the Humming Bird group, upon which there is a 2,000-foot

[1] Scott, W. A., The Hercules mill: Min. and Sci. Press, May 27, 1911, p. 724.

tunnel, the mouth of which is in the town of Burke. This adit will be continued to open the Hercules 800 feet below No. 4 adit, making No. 5 about 2 miles long. The statement of output made to the assessor gave 31,399 tons, a combination of crude ore shipped and concentrates made. The gross yield was $1,922,486; cost of extraction, $405,070; transportation, $219,230; reduction, $554,683; construction, $199,074; giving a net profit of $544,429. Dividends amounting to $150,000 were paid in 1911, making nearly $4,000,000 in all. The Marsh Mining Co., at Burke, became a shipper of rich ore and concentrate during the year. The 150-ton mill of the Pittsburg Co., in Placer Center district, was used for several months and the product shipped to Pittsburgh, Pa. The mine is opened by two adits and an incline shaft.

*Placer Center district.*—This region in Ninemile Canyon supplied 61,204 tons of sulphide ore, $532 in gold, 59,727 ounces of silver, 9,911 pounds of copper, 2,257,740 pounds of lead, and 6,586,905 pounds of zinc, in all valued at $510,428, or $8.34 per ton for the untreated ore. All of the ore was concentrated, making 12,291 tons of lead and zinc concentrates. The Rex mine was worked continuously, but the 400-ton mill which has been entirely remodeled, was only run a short time. The Pittsburg Lead Mining Co. shipped a few hundred tons of concentrate from ore from the Panhandle claim. From the Success mine, 4½ miles north of Wallace, a large quantity of zinc concentrate was shipped East, and some lead product to various plants. The 150-ton mill, which was said to have been improved with rolls, jigs, and tables, was operated the entire year; it shipped, according to the county assessor's figures, 7,948 tons of concentrates, of which the gross yield was $203,324. Various costs were $139,838, leaving a net profit of $63,486, from which dividends were paid amounting to $30,000. A clean separation of lead concentrate was made amounting to about one-tenth the mill product. Zinc concentrate has been shipped since 1905, but the output of 1911 was greater than that of any previous year.

*St. Joe district.*[1]—A slight amount of placer gold was sold and a small shipment of copper ore made from the Big Elk mine.

*Summit district.*—The output of 8 deep mines and 1 placer in this district, north of the main Cœur d'Alene mines, was 32,750 tons of sulphide ore, $2,074 in gold, 20,945 ounces of silver, 1,185 pounds of copper, 3,430,239 pounds of lead, and 536,188 pounds of zinc, valued in all at $198,246, or $6.03 per ton. This is a larger lead production than the district has ever had, and the first zinc output. Of the ore, 421 tons were shipped crude and 32,279 tons—mostly lead-zinc ore—concentrated, making 3,237 tons of concentrates. Small shipments were made from Black Horse, Cedar Creek, and Granite and Allie properties. A little gold ore was amalgamated at the Mother Lode mine in a 5-stamp mill. The Bear Top and Orofino mines were consolidated, and the 150-ton mill produced rich lead concentrates for a short time. Ore from the Chicago mine of the Paragon Consolidated Mining Co. was milled at the 150-ton concentration plant on the Black Horse property, resulting in 11 cars of zinc concentrate and 5 cars of lead concentrate. The largest part of the output of the

[1] Collier, A. J., Ore deposits of the St. Joe River basin, Idaho: Bull. U. S. Geol. Survey No. 285, 1906. Pardee, J. T., Geology and mineralization of the upper St. Joe River basin, Idaho: Bull. U. S. Geol. Survey No. 470, 1911.

district came from the Monarch mine and the 200-ton mill. The greater part of the product was lead concentrate, but a 40-per-cent zinc product was also separated. Eight deep mines and 1 placer made up the district totals.

*Yreka district.*—Seven deep mines near Wardner produced 920,649 tons of sulphide ore, containing $30,829 in gold, 2,793,937 ounces of silver, 448,626 pounds of copper, 118,725,981 pounds of lead, and 191,686 pounds of zinc, valued in all at $6,921,289, or $7.52 per ton of ore untreated. Crude ore shipped to smelters aggregated 16,828 tons and the remainder was reduced to 103,937 tons of concentrate. Metals produced in this district amounted in value to over 36 per cent of the total value of the State output. The Bunker Hill & Sullivan Mining & Concentrating Co. upheld its record of being the largest producer in the State. In the statement to the assessor ore extracted was given in as 464,750 tons and the gross yield as $3,306,360. Extraction of ore cost $1,012,016; transportation, $1,239,260, and improvements $256,336, leaving a net profit of $798,748. Dividends paid were $866,550—a total of over $13,000,000 in dividends. The high cost of improvements was due to mill building. The north mill, constructed for tailings, has a capacity of 800 tons per day; the south mill, 675 tons, and the first unit of the west mill 550 tons. The second unit of this last mill was being constructed and when completed the company will have a mill capacity of about 1,900 tons until the old mill is remodeled or rebuilt. From the Kellogg Tunnel level a winze on a 50-degree incline reached a vertical depth of 800 feet. The ore on these levels is reported of such extent and richness as to warrant many years of active mining. The Caledonia Mining Co. shipped 7,388 tons of lead ore, which contained much silver and considerable copper and required no milling. Tunnel driving was the main work during the year. The adit in Deadwood Gulch has reached the 2,500-foot mark and according to plans will tap the ore body at about 2,800 feet, or 500 feet below the lowest level reached by the incline shaft. Cost of extraction was $195,027; transportation, $93,050, and construction $37,404. As the gross yield was $364,217, the net profit was $38,736. At the Last Chance mine, or Wardner property of the Federal Mining & Smelting Co., the 500-ton mill was operated continuously and electricity was substituted for horse power in taking the ore through the Arizona tunnel. A sorting plant was also added so as to take waste from the mill feed and ship more first-class ore. The county assessor's figures are as follows: Ore extracted, 207,100 tons; gross yield, $1,624,142; cost of extraction, $814,090; transportation, $522,199; construction, $23,996; net profit, $263,857. In December ore from the Ontario mine was treated in a 150-ton leased mill at the mouth of the Silver King tunnel. The Stewart Mining Co. maintained an average output of about 450 tons of concentrating ore per day, treated at the Wallace mill of the Federal Co. Only a small percentage was crude shipping ore. A 3,000-foot tunnel being driven by contract reached the 1,823-foot mark. The county assessor's figures are as follows: Ore extracted, 147,503 tons; gross yield, $1,117,159; cost of extraction, $302,710; transportation, $31,986; reduction, $339,223; construction, $75,481; net profit, $367,759. From the Surprise mine on Pine Creek several thousand tons of ore were run through a 50-ton concentration plant, which produced both a lead and a zinc concentrate.

### TWIN FALLS COUNTY.

*Snake River district.*—Gold valued at $2,051 and 6 ounces of silver came from sluicing operations on 10 placers near Twin Falls.

### WASHINGTON COUNTY.

This county as established in the early part of the year retains only about half its former area, including the Heath district and the Washington district at Mineral. There was no output of importance.

## MONTANA.

By V. C. Heikes.

### PRODUCTION.

There were 430 producing deep mines in Montana in the calendar year 1911, which yielded 4,940,303 tons of ore, and 180 placers producing bullion which contained $687,516 in gold and silver. Altogether the combined output of gold, silver, copper, lead, and zinc had a total value of $46,955,287 in 1911, as against an output valued at $48,358,253 made by 578 producers in 1910. The decrease in value of the total output, amounting to $1,402,966, was caused chiefly by the decrease of $2,064,723 in value of the copper output. This decrease, with decreases of $19,915 in gold and $215,788 in silver, offset in part by increases of $108,744 in lead and $788,716 in zinc, brought the total decrease up to $1,402,966. Silver Bow County is credited with the largest output of ore, aggregating 4,569,942 tons, and valued at $42,741,229, which is 91.03 per cent of the total value for the State. The ore contained chiefly copper, amounting to 72.63 per cent of the copper value for the State, with important values additional in silver and zinc. The value of the metal output of Madison County, next in importance, was $927,974, of which 63.04 per cent was for the placer gold. Jefferson County followed, with a mine output valued at $646,843, of which 67.49 per cent was for silver. Broadwater County mines yielded an output valued at $637,024, of which the gold value from deep mines constituted the largest part, or 94.27 per cent. At gold and silver mills 249,120 tons of ore, or 5.04 per cent of the total ore mined, was treated by amalgamation and cyanidation processes, by which were recovered 55,746.45 ounces of gold, or 31.06 per cent of the total, and 122,823 ounces of silver, or 1.02 per cent of the total. Smelters treated 1,320,679 tons of concentrates, from which were recovered 29,029.14 ounces of gold, 7,751,426 ounces of silver, 194,406,298 pounds of copper, 2,137,327 pounds of lead, and 43,734,150 pounds of zinc, with a total value of $31,598,154. The smelters also treated 645,903 tons of crude ore, containing 61,568 ounces of gold, 4,105,092 ounces of silver, 73,172,276 pounds of copper, 4,294,248 pounds of lead, and 75,995 pounds of zinc, with a total value of $12,792,529. Therefore, the smelters received ore and concentrates containing 61.9 per cent of the gold, 98.97 per cent of the silver, all of the copper, lead, and zinc, and 95.9 per cent of the total value of the deep-mine output. The statements of production for 1910 and 1911, showing increase and decrease and valued at each year's commercial prices, is as follows:

*Mine production of gold, silver, and associated metals in Montana in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 180,462.26 | $3,730,486 | 179,498.87 | $3,710,571 | − 963.39 | − $19,915 |
| Silver.....do.... | 12,162,857 | 6,567,942 | 11,985,196 | 6,352,154 | − 177,661 | − 215,788 |
| Copper.....pounds.. | 284,808,553 | 36,170,686 | 272,847,705 | 34,105,963 | −11,960,848 | −2,064,723 |
| Lead.....do.... | 4,106,292 | 180,677 | 6,431,575 | 289,421 | + 2,325,283 | + 108,744 |
| Zinc.....do.... | 31,638,184 | 1,708,462 | 43,810,145 | 2,497,178 | +12,171,961 | + 788,716 |
| Total..... | ..... | 48,358,253 | ..... | 46,955,287 | ..... | −1,402,966 |

Statistics of Montana's ore and its metallic content produced during the past eight years are as follows:

*Output of ore sold or treated in Montana in 1904–1911, and total content of gold, silver, copper, lead, and zinc.*[a]

| Year. | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1904..... | 4,643,092 | 206,419.45 | 12,817,285 | 290,681,572 | 2,299,291 | ..... | $48,974,381 |
| 1905..... | 5,020,137 | 231,913.75 | 13,231,300 | 304,723,526 | 6,264,998 | 1,560,000 | 60,709,155 |
| 1906..... | 5,497,971 | 216,188.56 | 11,980,705 | 290,700 975 | 4,462,979 | 6,579,000 | 69,257,083 |
| 1907..... | 4,148,496 | 158,970.51 | 9,317,605 | 220,108,792 | 3,748,304 | 243,100 | 53,670,592 |
| 1908..... | 4,266,022 | 147,913.33 | 10,356,199 | 251,667,795 | 4,596,570 | 1,640,000 | 42,036,710 |
| 1909..... | 5,421,185 | 183,414.30 | 12,378,714 | 312,058,011 | 2,983,430 | 9,359,724 | 51,429,694 |
| 1910..... | 5,079,446 | 180,462.26 | 12,162,857 | 284,808,553 | 4,106,292 | 31,638,184 | 48,358,253 |
| 1911..... | 4,940,303 | 179,498.87 | 11,985,196 | 272,847,705 | 6,431,575 | 43,810,145 | 46,955,287 |

[a] Includes placer production in each year.

## ORE PRODUCTION IN 1911.

The quantity of ore mined in Montana and sold or treated decreased from 5,079,446 tons in 1910 to 4,940,303 tons in 1911. The total average value per ton decreased from $9.41 to $9.36 and the gold and silver value per ton from $1.91 to $1.90. Nineteen counties in Montana have producing mines and all except 7 produced increased quantities of ore. The decreases in ore tonnage were greatest in Silver Bow and Fergus counties. The output of dry or siliceous ore mined decreased from 385,067 tons in 1910 to 369,241 tons in 1911, that of copper ores from 4,517,709 tons to 4,332,479 tons, and that of copper-lead ores from 1,524 tons to 1,177 tons. Increases were made in the mining of lead ore from 5,951 tons in 1910 to 11,692 tons in 1911, of zinc ore from 169,165 tons to 225,586 tons, and of lead-zinc ores from 30 tons to 128 tons. Fergus, Chouteau, and Jefferson county mines yielded the largest quantity of dry or siliceous ores. In Broadwater County, at Radersburg, the largest quantity of sulphide iron ores was mined, and near Elkhorn and in Jefferson County the largest quantity of oxidized iron ores. The dry or siliceous ores, of which 369,241 tons were mined in 1911, are further divided into gold and gold-silver ore and silver ore. There were 296,947 tons of gold and gold-silver ore, averaging per ton $7.45 in gold, 0.82 ounce of silver, 0.84 pound of copper, and 0.42 pound of lead. This includes the content of 24,591 tons of auriferous sulphide ore and 9,549 tons of oxidized iron ore. Silver ores

aggregating 72,294 tons were mined, containing an average per ton of $1.24 in gold, 18.95 ounces of silver, 0.52 pound of copper, and 22.19 pounds of lead. Zinc sulphide ores were mined exclusively at Butte, in Silver Bow County, and lead ore was largely produced from mines in Lincoln County, and as usual from mines in Jefferson County. The total average yield per ton of gold and silver in dry or siliceous ores mined in 1911 was $8.56, against $9.19 in 1910; in copper ores, $1.32, against $1.24 in 1910; in lead ores, $13.28, against $27.83 in 1910; in zinc ore, $1.23, against $2.23 in 1910; in copper-lead ores, $41.82, against $31.22 in 1910. No gold and silver was reported in lead-zinc ores. Milling ores aggregated 4,287,849 tons, which is 86.79 per cent of the total ore mined, and the remainder, 645,903 tons, or 13.08 per cent, were shipped crude to the smelters. Of the total milling ore, 249,120 tons were treated by amalgamation and cyanidation processes, and the remainder, 4,038,729 tons, by concentration alone.

The total output of each kind of ore mined is as follows:

*Output of ore and production of metals in Montana in 1911, by kinds of ore.*

| Source of production. | Number of producers. | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Placers | 180 | ..... | 33,127.25 | 5,123 | ..... | ..... | ..... |
| Siliceous ore | 292 | 369,241 | 111,487.49 | 1,613,253 | 288,183 | 1,727,853 | ..... |
| Copper ore | 36 | 4,332,479 | 31,300.27 | 9,597,752 | 271,079,252 | 2,005 | ..... |
| Lead ore | 102 | 11,692 | 2,717.90 | 186,926 | 35,623 | 3,047,382 | ..... |
| Zinc ore | 2 | 225,586 | 817.15 | 491,161 | 1,340,427 | 846,680 | 43,734,150 |
| Copper-lead ore | 5 | 1,177 | 48.81 | 90,981 | 104,220 | 790,209 | ..... |
| Lead-zinc ore | 1 | 128 | ..... | ..... | ..... | 17,446 | 75,995 |
| Total | ..... | 4,940,303 | 179,498.87 | 11,985,196 | 272,847,705 | 6,431,575 | 43,810,145 |

Each kind of ore produced from the mines in 18 counties is given as follows:

*Subdivision of tonnage of ore sold or treated in Montana in 1911, by counties, in short tons.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|
| Beaverhead | 842 | 149 | 69 | ..... | 1,095 | ..... | 2,155 |
| Broadwater | 27,355 | 21 | 396 | ..... | ..... | ..... | 27,772 |
| Cascade | 1,160 | ..... | 1,802 | ..... | ..... | ..... | 2,962 |
| Chouteau | 69,493 | ..... | ..... | ..... | ..... | ..... | 69,493 |
| Deer Lodge | 5,656 | ..... | ..... | ..... | ..... | ..... | 5,656 |
| Fergus | 98,418 | ..... | ..... | ..... | ..... | 128 | 98,546 |
| Granite | 8,940 | 2 | 415 | ..... | ..... | ..... | 9,357 |
| Jefferson | 66,232 | 1,132 | 2,250 | ..... | ..... | ..... | 69,614 |
| Lewis and Clark | 43,322 | 24 | 504 | ..... | ..... | ..... | 43,850 |
| Lincoln | 10 | ..... | 4,632 | ..... | ..... | ..... | 4,642 |
| Madison | 28,260 | 25 | 449 | ..... | 31 | ..... | 28,765 |
| Meagher | 4 | 12 | ..... | ..... | 51 | ..... | 67 |
| Missoula | 4,470 | ..... | 57 | ..... | ..... | ..... | 4,527 |
| Park | ..... | ..... | 58 | ..... | ..... | ..... | 58 |
| Powell | 2,177 | 68 | 291 | ..... | ..... | ..... | 2,536 |
| Ravalli | ..... | ..... | 225 | ..... | ..... | ..... | 225 |
| Sanders | ..... | 73 | 63 | ..... | ..... | ..... | 136 |
| Silver Bow | 12,902 | 4,330,973 | 481 | 225,586 | ..... | ..... | 4,569,942 |
| Total | [a] 369,241 | 4,332,479 | 11,692 | 225,586 | 1,177 | 128 | 4,940,303 |
| Value per ton in gold and silver | $8.56 | $1.32 | $13.28 | $1.23 | $41.82 | ..... | $1.90 |

[a] 296,947 tons gold and gold-silver ores (includes 24,591 tons of auriferous sulphides and 9,549 tons of oxidized iron ores); 72,294 tons of silver ores.

## GOLD.

The output of gold decreased from 180,462.26 fine ounces, valued at $3,730,486, in 1910 to 179,498.87 ounces, valued at $3,710,571, in 1911. The largest decrease, or $278,171, was made by the mines in Fergus County, which was fully offset by the increase in Broadwater County of $283,687. Deep or lode mines in Silver Bow County yielded the largest amount, or $725,730 in gold, followed by Broadwater County with $600,519, and by Chouteau County next with $433,776. Important amounts came also from mines in Fergus and Lewis and Clark counties. The largest yield of gold from placer mining was made in Madison County, which was credited with $584,948, followed by Lewis and Clark County with $26,728. Eight dredging plants extracted gold from gravels in 5 districts in Madison, Missoula, Lewis and Clark, and Powell counties amounting to $597,778, or 87.29 per cent of the placer gold output, which was $684,801 in 1911. The output of 1910 was valued at $575,917. At amalgamation and cyanide mills $1,152,381 in gold was produced with an average recovery of $4.63 per ton of ore and tailings treated. Ores treated at concentration mills, producing concentrates, contained $600,086 in gold, averaging 45 cents per ton. The crude ore of shipping grade to smelters contained $1,272,723 in gold, or an average of $1.97 per ton.

*Source of gold production in Montana, by kinds of ore, in 1911, by counties, in fine ounces.*

| County. | Placers. | Deep mines. | | | | | Total. |
|---|---|---|---|---|---|---|---|
| | | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | |
| Beaverhead | 70.39 | 2,046.39 | 2.57 | 6.21 | ..... | 44.30 | 2,169.86 |
| Broadwater | 247.82 | 28,599.60 | 23.54 | 426.97 | ..... | ..... | 29,297.93 |
| Cascade | ..... | 74.63 | ..... | 59.56 | ..... | ..... | 134.19 |
| Chouteau | 2.90 | 20,983.92 | ..... | ..... | ..... | ..... | 20,986.82 |
| Deer Lodge | 13.79 | 3,241.03 | ..... | ..... | ..... | ..... | 3,254.82 |
| Fergus | 3.19 | 17,343.17 | ..... | ..... | ..... | ..... | 17,346.36 |
| Gallatin | 20.51 | ..... | ..... | ..... | ..... | ..... | 20.51 |
| Granite | 125.00 | 6,597.75 | .28 | 22.38 | ..... | ..... | 6,745.41 |
| Jefferson | 208.88 | 3,846.11 | 103.29 | 490.27 | ..... | ..... | 4,648.55 |
| Lewis and Clark | 1,292.97 | 11,022.12 | .66 | 188.46 | ..... | ..... | 12,504.21 |
| Lincoln | 183.24 | 39.42 | ..... | 212.57 | ..... | ..... | 435.23 |
| Madison | 28,296.86 | 12,360.28 | 94.26 | 865.41 | ..... | 4.51 | 41,621.32 |
| Meagher | 1.84 | 4.22 | .08 | ..... | ..... | ..... | 6.14 |
| Missoula | 986.61 | 701.44 | ..... | ..... | ..... | ..... | 1,688.05 |
| Park | 108.12 | ..... | ..... | 27.81 | ..... | ..... | 135.93 |
| Powell | 1,129.22 | 1,493.90 | 3.04 | 281.90 | ..... | ..... | 2,908.06 |
| Ravalli | 137.19 | ..... | ..... | 41.31 | ..... | ..... | 178.50 |
| Sanders | ..... | ..... | 10.11 | .97 | ..... | ..... | 11.08 |
| Silver Bow | 298.72 | 3,133.51 | 31,062.44 | 94.08 | 817.15 | ..... | 35,405.90 |
| Total | 33,127.25 | [a]111,487.49 | 31,300.27 | 2,717.90 | 817.15 | 48.81 | 179,498.87 |

[a] 107,134.68 ounces from gold and gold-silver ores (includes 23,512.11 ounces from auriferous sulphides and 3,864.13 ounces from oxidized iron ores); 4,352.82 ounces from silver ores.

## SILVER.

In 1911 the output of silver amounted to 11,985,196 fine ounces, valued at $6,352,154. Compared with the figures of 1910 this indicated a decrease of 177,661 ounces in quantity and of $215,788 in value. The decreased yield was mainly from the mines in Jefferson and Silver Bow counties, whose combined output is 92.46 per cent of the total, or 11,081,826 ounces, but is 348,593 ounces less than in 1910. Granite, Madison, and Beaverhead County mines produced over 100,000 ounces each. Copper ore produced from Silver Bow County mines, credited with 9,565,234 ounces, or 79.81 per cent of the total silver, and siliceous ore mined in Jefferson County containing 751,136 ounces, are the principal sources of silver. At gold and silver mills, the largest quantity of silver recovered by amalgamation was from ores mined in Lewis and Clark County, and by cyanidation from ores produced in Chouteau and Madison counties.

*Source of silver production in Montana, by kinds of ore, in 1911, by counties, in fine ounces.*

| County. | Placers. | Deep mines. | | | | | Total. |
|---|---|---|---|---|---|---|---|
| | | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | |
| Beaverhead | 5 | 7,302 | 2,634 | 2,443 | ..... | 90,480 | 102,864 |
| Broadwater | 33 | 5,257 | 169 | 7,928 | ..... | ..... | 13,387 |
| Cascade | ..... | 46,300 | ..... | 53,525 | ..... | ..... | 99,825 |
| Chouteau | ..... | 48,519 | ..... | ..... | ..... | ..... | 48,519 |
| Deer Lodge | 1 | 73,841 | ..... | ..... | ..... | ..... | 73,842 |
| Fergus | 1 | 8,675 | ..... | ..... | ..... | ..... | 8,676 |
| Gallatin | 1 | ..... | ..... | ..... | ..... | ..... | 1 |
| Granite | 11 | 321,335 | 89 | 29,417 | ..... | ..... | 350,852 |
| Jefferson | 39 | 751,136 | 28,137 | 44,392 | ..... | ..... | 823,704 |
| Lewis and Clark | 179 | 49,821 | 7 | 7,576 | ..... | ..... | 57,583 |
| Lincoln | 17 | 6 | ..... | 15,009 | ..... | ..... | 15,032 |
| Madison | 4,516 | 90,173 | 176 | 7,077 | ..... | 415 | 102,357 |
| Meagher | ..... | 1 | 5 | ..... | ..... | 86 | 92 |
| Missoula | 52 | 46 | ..... | 2,490 | ..... | ..... | 2,588 |
| Park | 21 | ..... | ..... | 243 | ..... | ..... | 264 |
| Powell | 163 | 17,050 | 1,242 | 7,204 | ..... | ..... | 25,659 |
| Ravalli | 10 | ..... | ..... | 949 | ..... | ..... | 959 |
| Sanders | ..... | ..... | 59 | 811 | ..... | ..... | 870 |
| Silver Bow | 74 | 193,791 | 9,565,234 | 7,862 | 491,161 | ..... | 10,258,122 |
| Total | 5,123 | [a]1,613,253 | 9,597,752 | 186,926 | 491,161 | 90,981 | 11,985,196 |

[a] Includes 243,125 ounces from gold and gold-silver ores (includes 300 ounces from auriferous sulphides and 2,101 ounces from oxidized iron ores); 1,370,128 ounces from silver ores.

## COPPER.

Copper production in Montana aggregated 272,847,705 pounds, valued at $34,105,963. As compared with the output of 1910, this showed a decrease of 11,960,848 pounds, which is almost entirely credited to Silver Bow County mines. In 1910, when the production was 284,808,553 pounds, the decrease was 27,249,458 pounds compared with the output of 1909. These decreases for the last two years were due mainly to the operation of the great properties under conditions caused by an agreement to curtail the copper output. Crude copper ore smelted in 1911 yielded 72,765,235 pounds, or an average of 128.6 pounds per ton. Dry or siliceous ores contained 274,781 pounds of copper, or 3.81 pounds per ton; lead ores, 28,040

pounds of copper, or 4.37 pounds per ton; copper-lead ores, 104,220 pounds of copper, or 88.55 pounds per ton. Ores smelted from Silver Bow County mines produced 26.61 per cent of the total copper, and ores from Jefferson, Broadwater, and Beaverhead County mines yielded over 100,000 pounds of copper each. Copper concentrates smelted contained 193,045,596 pounds of copper, or an average of 153.8 pounds per ton of concentrates. Dry or siliceous concentrates contained 11,007 pounds of copper, or 7.66 pounds per ton; lead concentrates, 9,268 pounds, or 3.69 pounds per ton; and zinc concentrates, 1,340,427 pounds, or 21.91 pounds per ton. The bulk of the copper in concentrates was from Silver Bow County mines. Copper precipitates from mine waters and the leaching of old tailings aggregated 5,075,288 pounds, which was recovered by the use of scrap iron as a precipitant, and 193,786 pounds of copper were contained in old smelter cleanings resmelted.

*Source of copper production in Montana, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Total. |
|---|---|---|---|---|---|---|
| Beaverhead | 3,013 | 36,259 | 179 | ..... | 98,126 | 137,577 |
| Broadwater | 135,367 | 2,678 | 2,513 | ..... | ..... | 140,558 |
| Cascade | 14 | ..... | 5,300 | ..... | ..... | 5,314 |
| Deer Lodge | 7,463 | ..... | ..... | ..... | ..... | 7,463 |
| Granite | 14,974 | 262 | 1,391 | ..... | ..... | 16,627 |
| Jefferson | 57,979 | 95,573 | 8,167 | ..... | ..... | 161,719 |
| Lewis and Clark | 2,024 | 4,459 | 919 | ..... | ..... | 7,402 |
| Madison | 19,157 | 2,402 | 1,328 | ..... | 2,646 | 25,533 |
| Meagher | ..... | 7,414 | ..... | ..... | 3,448 | 10,862 |
| Powell | 35,753 | 5,625 | 90 | ..... | ..... | 41,468 |
| Ravalli | ..... | ..... | 7,053 | ..... | ..... | 7,053 |
| Sanders | ..... | 13,025 | 1,933 | ..... | ..... | 14,958 |
| Silver Bow | 12,439 | 270,911,555 | 6,750 | 1,340,427 | ..... | 272,271,171 |
| Total | [a]288,183 | 271,079,252 | 35,623 | 1,340,427 | 104,220 | 272,847,705 |

a Includes 250,424 pounds from gold and gold-silver ores (includes 133,703 pounds from auriferous sulphides and 46,402 pounds from oxidized iron ore); 37,759 pounds from silver ores.

## LEAD.

The production of lead in 1911 aggregated 6,431,575 pounds, valued at $289,421, as against 4,106,692 pounds, valued at $180,677 in 1910. The greatest increase in lead production was by mines in Lincoln County, followed by Silver Bow, Cascade, Beaverhead, and Jefferson counties. The largest production was in Jefferson County, which is credited with 2,088,336 pounds, and Silver Bow County ranked next with 1,017,273 pounds, followed by Cascade County with 861,613 pounds. Crude ores smelted contained 4,294,248 pounds of lead, of which 49.20 per cent, or 2,112,918 pounds, was contained in lead ores smelted, and 31.94 per cent, or 1,371,670 pounds, in dry or siliceous ores smelted. Copper-lead ores smelted contained 790,209 pounds of lead. Concentrates smelted contained 2,137,327 pounds of lead, which is two-thirds more than was produced from concentrates in 1910. The increase was credited to Lincoln, Cascade, and Silver Bow counties. The Jefferson County output of lead contained in concentrate decreased. Of the total quantity smelted, 2,506 tons were

lead concentrates, containing 1,290,647 pounds of lead, or an average of 515.02 pounds per ton. Zinc concentrates aggregating 61,165 tons yielded 846,680 pounds, or an average recovery of 13.84 pounds per ton from the zinc residues.

*Source of lead production in Montana, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|
| Beaverhead | 33,916 | 324 | 29,449 | ..... | 766,883 | ..... | 830,572 |
| Broadwater | 957 | ..... | 148,319 | ..... | ..... | ..... | 149,276 |
| Cascade | 61,376 | ..... | 800,237 | ..... | ..... | ..... | 861,613 |
| Fergus | ..... | ..... | ..... | ..... | ..... | 17,446 | 17,446 |
| Granite | 5,737 | ..... | 74,942 | ..... | ..... | ..... | 80,679 |
| Jefferson | 1,542,093 | ..... | 546,143 | ..... | ..... | ..... | 2,088,236 |
| Lewis and Clark | 6,574 | ..... | 109,572 | ..... | ..... | ..... | 116,146 |
| Lincoln | ..... | ..... | 816,211 | ..... | ..... | ..... | 816,211 |
| Madison | 12,118 | ..... | 202,516 | ..... | 10,782 | ..... | 225,416 |
| Meagher | ..... | ..... | ..... | ..... | 12,544 | ..... | 12,544 |
| Missoula | ..... | ..... | 28,979 | ..... | ..... | ..... | 28,979 |
| Park | ..... | ..... | 29,866 | ..... | ..... | ..... | 29,866 |
| Powell | 61,124 | 1,681 | 47,991 | ..... | ..... | ..... | 110,796 |
| Ravalli | ..... | ..... | 24,372 | ..... | ..... | ..... | 24,372 |
| Sanders | ..... | ..... | 22,150 | ..... | ..... | ..... | 22,150 |
| Silver Bow | 3,958 | ..... | 166,635 | 846,680 | ..... | ..... | 1,017,273 |
| Total | [a]1,727,853 | 2,005 | 3,047,382 | 846,680 | 790,209 | 17,446 | 6,431,575 |

[a] Includes 123,809 pounds from gold and gold-silver ores (includes 3,401 pounds from oxidized iron ore); 1,604,044 pounds from silver ores.

## ZINC.

The production of zinc was confined to Silver Bow and Fergus counties during 1911, but some ore was shipped for trial purposes from a Jefferson County mine, which may be a future source of zinc. The output of 1911 aggregated 43,810,145 pounds of zinc, figured as spelter, valued at $2,497,178, as against a production of 31,638,184 pounds, valued at $1,708,462 in 1910. In 1909 there were 9,359,724 pounds of zinc produced in Montana, and 1,640,000 pounds in 1908. The Butte-Superior, or Black Rock mine, at Butte, yielded from its ores treated at Basin the bulk of 61,165 tons of sulphide zinc concentrate, assaying from 45 to 50 per cent of zinc. The Elm Orlu Co. also shipped zinc concentrate of about the same grade reduced from its ores treated at the Butte Reduction Works. A new mill on the Black Rock mine at Butte is under construction.

*Source of zinc production in Montana, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Zinc ore. | Lead-zinc ore. | Total. |
|---|---|---|---|
| Fergus | ..... | 75,995 | 75,995 |
| Silver Bow | 43,734,150 | ..... | 43,734,150 |
| Total | 43,734,150 | 75,995 | 43,810,145 |

## REDUCTION MILLS.

The following is a list of reduction mills in Montana in 1911:

*List of reduction mills in Montana in 1911, by counties.*

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| BEAVERHEAD COUNTY. | | | | *Short tons.* |
| Ajax[a] | Elkhorn | Amalgamation | 10 stamps | 30 |
| Dakota[a] | Polaris | Cyanidation | | 25 |
| BROADWATER COUNTY. | | | | |
| Slim Jim[b] | Backer | Amalgamation | 1 stamp | 1 |
| Eclipse[a] | do | Concentration | Crusher, 2 Huntington mills, 1 Wilfley table, 1 vanner. | 20 |
| East Pacific[a] | Beaver | Amalgamation, concentration. | 1 crusher, 2 roller mills, 3 jigs, 1 vanner, 1 Wilfley table. | 75 |
| Eclipse Argo[a] | do | Concentration | Crusher, 2 sets of rolls, 3 Hartz jigs, 2 Wilfley tables. | 25 |
| CASCADE COUNTY. | | | | |
| Morning Star[a] | Montana | Concentration | Crusher, 1 set of rolls, jigs. | 20 |
| I. X. L. and Eureka[b] | do | Cyanidation | 10 stamps | 25 |
| Broadwater[a] | do | Concentration | Crusher and tables | 30 |
| Barker[b] | do | do | do | 50 |
| Boston-Montana[b] | do | do | 18 Blake crushers, 8 stamps, 36 rolls, 88 jigs, 75 shaking tables, and 66 vanners. | 3,000 |
| CHOUTEAU COUNTY. | | | | |
| Ruby Gulch[b] | Little Rockies | Cyanidation | Crusher, 2 sets rolls, 13 tanks (capacity, 2,320 tons). | 300 |
| August[b] | do | do | 1 crusher, 2 rolls, 9 tanks (capacity, 1,020 tons). | 100 |
| DEER LODGE COUNTY. | | | | |
| Cable[a] | Georgetown | Amalgamation | 30 stamps | 100 |
| Southern Cross[b] | do | Cyanidation | Stamps, tanks, Dorr classifiers and thickeners. | 100 |
| Gold Coin[b] | do | Amalgamation, cyanidation. | 30 stamps | 200 |
| Victoria[b] | | | | |
| Washoe[b] | do | Concentration | 24 Blake crushers, 32 rolls, 24 Huntington mills, 280 tables, 528 jigs. | 10,300 |
| FERGUS COUNTY. | | | | |
| Kendall[b] | North Moccasin | Cyanidation | Crusher, rolls, 14 tanks (capacity, 2,352 tons). | 300 |
| Barnes King[a] | do | do | Crushers and tanks | 200 |
| Cumberland[b] | Warm Springs | do | 1 crusher, 1 set rolls, 10 tanks (capacity, 230 tons). | 150 |
| Gold Reef[b] | do | do | 1 crusher, 6 tanks (capacity, 400 tons). | 165 |
| Rhein[b] | do | do | Crushers and tanks | 150 |
| Maginnis[b] | do | Concentration, cyanidation. | Crusher, Huntington mill, 10 stamps, 6 cyanide tanks (capacity 280 tons), Diester tables, agitation | 25 |

[a] Idle in 1911. [b] Active in 1911.

*List of reduction mills in Montana in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| GRANITE COUNTY. | | | | *Short tons.* |
| Fourth of July [a] | First chance | Amalgamation, concentration. | 10 stamps, 2 Wilfley tables, 2 Woodbury and 1 Frue vanner. | 30 |
| Shamrock [a] | do | do | 20 stamps | 60 |
| Henderson [a] | do | do | 20 stamps, plates, Wilfley tables, and buddle. | 60 |
| Hope [a] | Flint Creek | do | 1 Blake crusher, 3 tables, 10 stamps. | 25 |
| Royal Gold [a] | do | do | 10 stamps | 30 |
| Granite-Bimetallic [a] | do | Amalgamation, concentration, chlorination. | Crushers, 100 stamps, tube mill, Wilfley tables, and 9 tanks. | 200 |
| Coyote [a] | do | Cyanidation | 3 stamps | 10 |
| American Flag [a] | Red Lion | Amalgamation, cyanidation. | Plates and tanks | 50 |
| Doherty (custom mill) [b] | do | do | Stamps, plates, and tanks. | 40 |
| Red Lion [b] | do | do | 10 stamps, plates, and tanks. | 30 |
| Sunday [b] | South Boulder | Cyanidation | 25-ton cyanide plant, 3½-foot Huntington mill. | 5 |
| North Star [a] | do | Sulphuric acid leaching plant. | 2 crushers, 2 roller mills, 4 leaching tanks. | 100 |
| Gold reef [a] | do | Cyanidation | 6 stamps and 40-ton cyanide plant. | 30 |
| Mount Royal [a] | do | do | 20 stamps | 50 |
| Crescent [b] | do | Amalgamation, cyanidation. | 20 stamps, plates, and Dorr classifiers. | 60 |
| Alps [a] | Alps | Cyanidation | 10 stamps | 30 |
| JEFFERSON COUNTY. | | | | |
| Ruby [b] | Cataract | Amalgamation, concentration. | Crusher, Wilfley tables, tanks. | 30 |
| Basin Reduction Works. [b] | do | Concentration | Crushers and table | 1,500 |
| Comet [a] | do | do | do | 100 |
| Corbin [a] | Colorado | do | Crusher and 2 tables | 100 |
| Elkhorn [b] | Elkhorn | do | Crusher, 20 stamps, 2 tables, Frue vanners. | 140 |
| Golden Curry [a] | do | Cyanidation | Crusher and tanks | 100 |
| Last Hope [a] | Mitchell | Amalgamation, concentration. | 5 stamps and 1 table | 25 |
| Gold Crown [a] | Lump Gulch | Concentration | Rolls, 2 sets jigs, and table. | 20 |
| Frohlmer [c] | do | do | Crushers and tables | 30 |
| Golden Sunlight [a] | Whitehall | Cyanidation | | 50 |
| LEWIS AND CLARK COUNTY. | | | | |
| Strawberry [b] | Bald Butte | Amalgamation | 10 stamps | 30 |
| Bald Butte [a] | do | Amalgamation, concentration. | 40 stamps | 100 |
| Stemple c. a. [b] | Gould | Amalgamation, cyanidation. | 2 crushers, 30 stamps, 10 tanks (capacity 100 tons). | 100 |
| Hubbard [b] | do | do | 10 stamps | 100 |
| May & Victor [b] | Greenhorn | do | do | 30 |
| Arrow Head and Old Dominion. [a] | Helena | Amalgamation, concentration. | 2 stamps | 2 |
| Northwestern Metals Co. [c] | do | Chlorination (dry) | Crusher, rolls, and 3 tube mills. | 40 |
| Cruse Bald Mt. [b] | Ottawa | Cyanidation | 20 stamps | 50 |
| Empire [a] | do | Amalgamation, cyanidation. | 60 stamps | 500 |
| Drumlummon [b] | do | Amalgamation, concentration, cyanidation. | 60 stamps, Dorr classifier, and thickeners. | 400 |
| August Eck [b] | do | Cyanidation | Tailings plant—2 cyanide tanks (75 tons each). | 25 |

[a] Idle in 1911. [b] Active in 1911. [c] Under construction in 1911.

*List of reduction mills in Montana in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| LEWIS AND CLARK COUNTY—contd. | | | | *Short tons.* |
| F. Aagaard [a] | Ottawa | Cyanidation | Tailings plant—6 sand tanks, 4 solution tanks. | 30 |
| Wolfram [a] | do | do | Tailings plant—tanks | 25 |
| G. Slater [b] | do | do | do | 25 |
| Gloster [b] | do | do | 60 stamps | 200 |
| Maly (on Day Creek) [a] | do | do | Three 60-ton tanks | 20 |
| Klondike [a] | Stemple | Amalgamation | 3 stamps | 2 |
| New Year [b] | do | do | | 25 |
| Whitlatch [b] | Unionville | Amalgamation, concentration. | 10 stamps | 30 |
| Spring Hill [b] | do | Cyanidation | | 70 |
| Twentieth Century [a] | Poorman | Amalgamation | 5 stamps | 20 |
| LINCOLN COUNTY. | | | | |
| Snowshoe [a] | Libby | Concentration | Crusher, rolls, jigs, and Wilfley tables. | 400 |
| Blacktail [a] | do | Amalgamation | 10 stamps | 10 |
| MADISON COUNTY. | | | | |
| U. S. Grant [b] | Alder Gulch | Amalgamation | 15 stamps | 45 |
| Prospect and Hidden Treasure. [b] | do | do | 10 stamps | 30 |
| Gleason [b] | Lower Hot Springs. | do | | 25 |
| Boss Tweed and Clipper. [a] | Mineral Hill | Amalgamation, concentration. | Crusher, 15 stamps, Wilfley table, and Frue vanner. | 50 |
| Ben Harrison Fraction. [a] | do | do | 4 stamps | 12 |
| Garnet [a] | do | do | 20 stamps and 5 Frue vanners. | 60 |
| Strawberry (custom) [a] | do | do | 10 stamps and 3 tables. | 25 |
| Gold Coin [c] | Rabbit | do | 5 stamps, 1 Wilfley table, 1 Frue vanner. | 30 |
| Fairview [b] | Sheridan | Amalgamation | 6 stamps and plates | 25 |
| Gladstone [a] | do | Amalgamation, concentration. | 10 stamps | 30 |
| Noble [b] | do | Amalgamation | | 30 |
| Iron Rod and Hudson [a] | Silver Star | Amalgamation, cyanidation. | 15 stamps | 50 |
| Green Campbell [b] | do | Concentration | 25 ton Huntington mill. | 100 |
| Easton-Pacific [a] | Summit | Concentration and cyanidation for tailings. | 10 stamps and Dorr classifiers. | 25 |
| Shafter [b] | do | Amalgamation, concentration, cyanidation. | Crusher, 5 stamps, 2 Frue vanners, 3 tanks. | 15 |
| Apex [a] | do | Amalgamation, concentration. | 10 stamps | 20 |
| Monitor and Revenue [a] | Upper Hot Springs. | Cyanidation | Crushers and tanks | 75 |
| George McKee [b] | Washington Gulch. | Amalgamation, concentration. | 5 stamps | 15 |
| Black Hawk [a] | do | do | 10 stamps | 30 |
| MEAGHER COUNTY. | | | | |
| Crown Point [a] | Musselshell | Amalgamation | 1 Dodge stamp and 5-foot Huntington mill. | 20 |
| MISSOULA COUNTY. | | | | |
| Iron Mountain Tunnel. [b] | Iron Mountain | Concentration | Crusher, 6 Wilfley tables. | 300 |
| Nine Mile [a] | Nine Mile | Amalgamation | Crusher and 20 stamps. | 75 |
| San Martina [b] | do | do | 5 stamps | 15 |
| Deer Creek [b] | St. Regis | Amalgamation, concentration. | Crusher, 3 Tremain mills, and 3 Wilfley tables. | 20 |
| Gold Chrome [a] | do | do | 10 stamps, one 22-foot tube mill, 1 Johnson table. | 150 |

[a] Active in 1911. [b] Idle in 1911. [c] Under construction in 1911

*List of reduction mills in Montana in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| POWELL COUNTY. | | | | |
| | | | | *Short tons.* |
| Victory [a] | Ophir | Amalgamation, concentration. | 10-foot Lane mill, and 6 Frue vanners. | 20 |
| Mutual [b] | Washington Gulch. | do | 5 stamps and Frue vanners. | 20 |
| Hansmeier [a] | do | Amalgamation | 5 stamps | 24 |
| Kineo [b] | Zozell | Concentration | Crusher, 2 rolls, and jigs. | 50 |
| SANDERS COUNTY. | | | | |
| Shamrock [b] | Prospect Creek | Amalgamation, concentration. | 5 stamps | 15 |
| SILVER BOW COUNTY. | | | | |
| Gold Hill [a] | Divide Creek | Cyanidation | Crusher, 2 Huntington mills, 9 tanks (capacity 100 tons). | 40 |
| Murphy [a] | Highland | Amalgamation | 5 stamps | 18 |
| Pittsmont [a] | Summit Valley | Concentration | 2 Crushers, 2 Chilian mills, 4 jigs, 6 Cravens and 16 Overstrom tables. | 350 |

[a] Active in 1911. [b] Idle in 1911.

The foregoing list of 105 mills, with the rough summary of equipment, was made as complete as it was possible to get it for 1911. Of the number given, 48 were idle, 54 were operating, and 3 were under construction or being remodeled. There were 18 mills using the amalgamation process, of which 9 were active; 27 were cyanide plants, 17 being in operation; 18 were concentration plants, 7 being active. Amalgamation and concentration methods were used in 25 mills, of which 8 were in operation; amalgamation and cyanide methods were used at 9 mills, of which 7 were active. Three mills equipped for cyanidation and concentration were all in operation. One mill to use the sulphuric acid leaching process was under construction. At another plant under construction, a modification of the chlorination process is to be used. Only 249,120 tons, or 5 per cent, of the total ore mined in Montana, and 6,201 tons of old tailings were treated either by amalgamation or cyanidation, or by both processes, with or without concentration equipment. Of the ore treated, 61,767 tons were treated by amalgamation and yielded 12,642.83 ounces of gold and 15,902 ounces of silver, or an average recovery of $4.23 in gold and 0.26 ounce of silver per ton. Part of the amalgamated ore, amounting to 10,358 tons, was given further treatment by the cyanide process, which, with the direct cyaniding of 187,353 tons of ore and 6,201 tons of old tailings, aggregated 203,912 tons, yielding 43,103.62 ounces of gold and 106,921 ounces of silver recovered by cyanidation. The ore averaged a recovery of $4.37 in gold and 0.49 ounce of silver, and old tailings, $4.34 in gold and 1.74 ounces of silver. An effort was made in 1911 to learn what quantity of quicksilver and of cyanides had been consumed. From reports received, 898 pounds of quicksilver were used at amalgamation mills, or an average of 0.0314 pound per ounce of

bullion recovered. Cyanide mills consumed 59,423 pounds of potassium cyanide and 32,234 pounds of sodium cyanide, or an average for both of 0.61 pound consumed per ounce of bullion recovered.

*Output of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Montana in 1911, by counties.*

| County. | Quantity. | Bullion recovered from ore by— | | | | Total value. |
|---|---|---|---|---|---|---|
| | | Amalgamation. | | Cyanidation. | | |
| | | Gold. | Silver. | Gold. | Silver. | |
| | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Fine ozs.* | *Fine ozs.* | |
| Broadwater | [a] 4 | 125.02 | 40 | | | $2,605 |
| Cascade | 150 | | | 17.64 | 362 | 557 |
| Chouteau | 69,493 | | | 20,983.92 | 48,519 | 459,491 |
| Deer Lodge | 3,299 | | | 1,101.09 | 338 | 22,940 |
| Fergus | [b] 98,331 | | | 16,465.18 | 6,366 | 343,740 |
| Granite | [c] 1,339 | 39.11 | 46 | [d] 889.61 | [d] 284 | 19,373 |
| Jefferson | 784 | 159.49 | 325 | | | 3,469 |
| Lewis and Clark | [e] 36,993 | 8,107.85 | 14,344 | [f] 1,706.28 | [f] 14,043 | 217,921 |
| Lincoln | 10 | 39.45 | 6 | | | 818 |
| Madison | [g] 25,911 | 2,407.19 | 848 | 1,411.30 | 36,856 | 98,918 |
| Meagher | 4 | 4.21 | 1 | | | 88 |
| Missoula | 4,470 | 701.44 | 46 | | | 14,525 |
| Park | 13 | 25.83 | 6 | | | 538 |
| Powell | [h] 1,177 | 660.75 | 210 | | | 13,770 |
| Silver Bow | 7,142 | 372.49 | 30 | 528.60 | 153 | 18,724 |
| Total | 249,120 | 12,642.83 | 15,902 | 43,103.62 | 106,921 | 1,217,477 |

[a] Also yielded sulphide concentrate, 1 ton.
[b] Sulphide, 40 tons.
[c] Sulphide, 33 tons.
[d] Includes bullion from 555 tons of old tailings.
[e] Sulphide, 58 tons.
[f] Includes bullion from 5,646 tons of old tailings.
[g] Principally sulphide, 1,318 tons.
[h] Sulphide, 7 tons.

Milling plants equipped for the concentration of low-grade or second-class ores treated 4,038,729 tons, which yielded 1,320,679 tons of concentrates, containing 29,029.14 ounces, or 16.17 per cent, of the total gold; 7,751,426 ounces, or 64.68 per cent, of the total silver; 194,406,298 pounds, or 71.25 per cent of the total copper; 2,137,327 pounds, or 33.23 per cent, of the total lead; and 43,734,150 pounds, or 99.83 per cent, of the total zinc (spelter), valued in all at $31,598,154, or an average of $23.93 per ton. Copper concentrates, aggregating 1,255,572 tons, comprised 95 per cent of the tonnage of the total concentrates produced, and gave an average recovery assay per ton of 38 cents in gold and 5.62 ounces of silver, and contained 7.69 per cent of copper, with a value of $22.58 per ton. The ore from which the copper concentrate was saved aggregated 3,766,143 tons, and averaged, according to concentrates saved, 13 cents in gold, 1.87 ounces of silver, and 2.56 per cent of copper, or an average of $7.53 per ton. Zinc sulphide concentrates, aggregating 61,165 tons, yielded an average of 35.75 per cent of spelter, and from the residues 28 cents in gold and 8.03 ounces of silver per ton, and 1.09 per cent of copper and 0.69 per cent of lead. Lead concentrates saved at concentration mills aggregated 2,485 tons, and contained an average of $4.01 in gold and 66.48 ounces of silver per ton, and 0.18 per cent of copper and 25.88 per cent of lead, having an average value of $62.99 per ton. The lead concentrate saved from ore at gold and silver mills after amalgamation aggregated 21 tons and

contained $34.81 in gold and 7.57 ounces of silver per ton, and 0.75 per cent of copper and 10.35 per cent of lead, or an average value of $50 per ton. Dry or siliceous concentrate saved after amalgamation of the ore yielded 1,436 tons of concentrate, containing $68.29 in gold and 24.10 ounces of silver per ton, and 0.38 per cent of copper, or an average value of $82.02 per ton.

*Mine production of gold, silver, copper, lead, and zinc from Montana concentrates in 1911, by counties.*

| County. | Ore to concentrating mills. | Concentrates produced. | | | | | | Total value of concentrates. |
|---|---|---|---|---|---|---|---|---|
| | | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Broadwater | | 1 | 17.93 | 63 | 27 | | | $407 |
| Cascade | 414 | 138 | 4.14 | 4,416 | 530 | 115,920 | | 7,708 |
| Fergus | | 40 | 651.60 | 1,603 | | | | 14,319 |
| Granite | | 33 | 119.85 | 160 | | | | 2,562 |
| Jefferson | 41,781 | 1,493 | 225.93 | 145,360 | 2,023 | 353,520 | | 97,872 |
| Lewis and Clark | | 58 | 60.39 | 2,408 | | 1,687 | | 2,600 |
| Lincoln | 4,610 | 785 | 210.99 | 14,598 | | 792,485 | | 47,761 |
| Madison | | 1,318 | 3,915.67 | 30,502 | 11,295 | 2,058 | | 98,615 |
| Powell | | 7 | 13.50 | 26 | | 605 | | 320 |
| Ravalli | 225 | 75 | 41.31 | 949 | 7,053 | 24,372 | | 3,336 |
| Silver Bow | 3,991,699 | 1,316,731 | 23,767.83 | 7,551,341 | 194,385,370 | 846,680 | 43,734,150 | 31,322,654 |
| Total | 4,038,729 | 1,320,679 | 29,029.14 | 7,751,426 | 194,406,298 | 2,137,327 | 43,734,150 | 31,598,154 |
| Subdivision by kinds of concentrates: | | | | | | | | |
| Dry or siliceous | | 1,436 | 4,743.60 | 34,603 | 11,007 | | | 117,774 |
| Copper | | 1,255,572 | 22,950.97 | 7,060,310 | 193,045,596 | | | 28,347,132 |
| Lead | | 2,506 | 517.43 | 165,352 | 9,268 | 1,290,647 | | 157,570 |
| Zinc | | 61,165 | 817.14 | 491,161 | 1,340,427 | 846,680 | 43,734,150 | 2,975,708 |

*Kinds of concentrates and average metallic content of milling ore and concentrates produced in Montana in 1911.*

| Kinds of concentrates and source of. | Milling ore. | Concentrate. | Average metallic content per ton. | | | | | | | | | | Average value per ton. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gold. | | Silver. | | Copper. | | Lead. | | Zinc. | | Crude ore. | Concentrate. |
| | | | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | | |
| Dry or siliceous: | *Short tons.* | *Short tons.* | | | *Fine ozs.* | *Fine ozs.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | | |
| Gold and silver mills | 36,008 | 1,436 | $2.72 | $68.29 | 0.96 | 24.10 | 0.01 | 0.38 | ..... | ..... | ..... | ..... | $3.27 | $82.02 |
| Copper: | | | | | | | | | | | | | | |
| Concentration mills | 3,766,143 | 1,255,572 | .13 | .38 | 1.87 | 5.62 | 2.56 | 7.69 | ..... | ..... | ..... | ..... | 7.53 | 22.58 |
| Lead: | | | | | | | | | | | | | | |
| Gold and silver mills | 303 | 21 | 2.41 | 34.81 | .52 | 7.57 | .05 | .75 | 0.72 | 10.35 | ..... | ..... | 3.47 | 50.00 |
| Concentration mills | 47,000 | 2,485 | .21 | 4.01 | 3.51 | 66.48 | .01 | .18 | 1.37 | 25.88 | ..... | ..... | 3.33 | 62.99 |
| Zinc: | | | | | | | | | | | | | | |
| Concentration mills | 225,586 | 61,165 | .07 | .28 | 2.18 | 8.03 | .25 | 1.09 | .19 | .69 | 9.69 | 35.75 | 13.19 | 48.65 |

There were 645,903 tons of crude smelting ores shipped, the bulk of it going to Montana plants, but some also to Utah. The ore smelted contained 61,568 ounces, or 34.3 per cent of the total gold output; 4,105,092 ounces, or 34.25 per cent of the total silver; 73,172,276 pounds, or 26.81 per cent of the total copper; 4,294,248 pounds, or 66.77 per cent of the total lead; and 75,995 pounds, or 0.17 per cent of the total zinc, having a total value of $12,792,529, or an average of $19.81 per ton. In 1910 the total value of 616,596 tons of smelting ore was $10,638,348, or an average of $17.25 per ton. Nearly nine-tenths of the ore smelted in 1911, which aggregated 566,044 tons, was copper ore, containing an average of 30 cents in gold and 4.48 ounces of silver per ton, and 6.43 per cent of copper, and averaging $18.75 in value per ton. Dry or siliceous ores smelted aggregated 72,135 tons, and contained $14.54 in gold and 18.16 ounces of silver per ton, and 0.19 per cent of copper and 0.95 per cent of lead, with an average value of $25.50 per ton. Lead ores were smelted aggregating 6,419 tons, which contained an average of $7.81 in gold and 25.99 ounces of silver per ton, and 0.27 per cent of copper and 16.46 per cent of lead, with an average value of $36.95 per ton. Copper-lead ores yielded from 1,177 tons smelted an average of 86 cents in gold and 77.30 ounces of silver per ton, and 4.43 per cent of copper and 33.57 per cent of lead, and averaged in value $83.11 per ton. There were 128 tons of lead-zinc carbonate treated, yielding an average of 6.81 per cent of lead and 29.69 per cent of spelter, averaging in value $39.98 per ton. Near Anaconda and Great Falls, the two copper smelting establishments of the Anaconda Copper Co. were in full operation during 1911, as was the Pittsmont plant, at Butte, of the East Butte Copper Co. These plants received the bulk of the copper ores mined. Nearly all of the Montana ores containing lead were smelted at East Helena, where a large quantity of Idaho lead ores and concentrates was also treated. A small part of the lead ore was shipped to Utah plants.

*Mine production of gold, silver, copper, lead, and zinc from Montana crude ore shipped to smelters in 1911, by counties.*

| County. | Crude ore to smelter. | | | | | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Beaverhead | 2,155 | 2,099.47 | 102,859 | 137,577 | 830,572 | ..... | $152,488 |
| Broadwater | 27,768 | 28,907.16 | 13,251 | 140,531 | 149,276 | ..... | 628,870 |
| Cascade | 2,398 | 112.41 | 95,047 | 4,784 | 745,693 | ..... | 86,853 |
| Deer Lodge | 2,357 | 2,139.94 | 73,503 | 7,463 | ..... | ..... | 84,125 |
| Fergus | 215 | 226.39 | 706 | ..... | 17,446 | 75,995 | 10,171 |
| Granite | 7,463 | 5,571.84 | 350,351 | 16,627 | 80,679 | ..... | 306,575 |
| Jefferson | 27,049 | 4,054.25 | 677,980 | 159,696 | 1,734,716 | ..... | 541,162 |
| Lewis and Clark | 1,211 | 1,336.72 | 26,609 | 7,402 | 114,459 | ..... | 47,811 |
| Lincoln | 22 | 1.55 | 411 | ..... | 23,726 | ..... | 1,318 |
| Madison | 2,826 | 5,564.27 | 29,593 | 14,181 | 223,358 | ..... | 142,531 |
| Meagher | 63 | .09 | 91 | 10,862 | 12,544 | ..... | 1,972 |
| Missoula | 57 | ..... | 2,490 | ..... | 28,979 | ..... | 2,624 |
| Park | 45 | 1.98 | 237 | ..... | 29,866 | ..... | 1,511 |
| Powell | 1,359 | 1,104.59 | 25,260 | 41,468 | 110,191 | ..... | 46,365 |
| Sanders | 136 | 11.08 | 870 | 14,958 | 22,150 | ..... | 3,557 |
| Silver Bow | 570,779 | 10,436.26 | 2,705,834 | 72,616,727 | 170,593 | ..... | 10,734,596 |
| Total | 645,903 | 61,568.00 | 4,105,092 | 73,172,276 | 4,294,248 | 75,995 | 12,792,529 |
| Subdivision by kinds of ore: | | | | | | | |
| Dry or siliceous | 72,135 | 50,746.56 | 1,310,363 | 274,781 | 1,371,670 | ..... | 1,839,588 |
| Copper | 566,044 | 8,347.59 | 2,536,882 | 72,765,235 | 2,005 | ..... | 10,612,852 |
| Lead | 6,419 | 2,425.05 | 166,866 | 28,040 | 2,112,918 | ..... | 237,155 |
| Copper-lead | 1,177 | 48.80 | 90,981 | 104,220 | 790,209 | ..... | 97,817 |
| Lead-zinc | 128 | ..... | ..... | ..... | 17,446 | 75,995 | 5,117 |

*Crude ore, by kinds, and average metallic content of each kind shipped to smelters in Montana in 1911.*

| Kind of crude ore. | Quantity. | Average metallic content per ton. | | | | | Average value per ton. |
|---|---|---|---|---|---|---|---|
| | | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | | *Fine ozs.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Dry or siliceous | 72,135 | $14.54 | 18.16 | 0.19 | 0.95 | ..... | $25.50 |
| Copper | 586,044 | .30 | 4.48 | 6.43 | ..... | ..... | 18.75 |
| Lead | 6,419 | 7.81 | 25.99 | .27 | 16.46 | ..... | 36.95 |
| Copper-lead | 1,177 | .86 | 77.30 | 4.43 | 33.57 | ..... | 83.11 |
| Lead-zinc | 128 | ..... | ..... | ..... | 6.81 | 29.69 | 39.98 |

## MINING INDUSTRY IN MONTANA IN 1911.

Although mining and financial conditions have been against extensive operations throughout the copper districts of Montana in 1911, considerable mining activity was in evidence in some of the gold and silver districts. Radersburg, in Broadwater County, Georgetown, in Deer Lodge County, Marysville, in Lewis and Clark County, and Libby, in Lincoln County, each made substantial records of production. In the placer districts, the principal part of the gold yield was made by dredges which were the means of increasing the total output over that made in recent years. At Butte, the copper center, 23 mines of the Anaconda Copper Mining Co. were operated continuously, as were the North Butte, East Butte, Tuolumne, Davis Daly, Alex Scott, and Butte & Balaklava mines. Zinc became an important factor in the metal output of Butte in 1911, and was the yield of ore mined from 2 properties, the Butte-Superior and Elm Orlu. The copper mines were operated under somewhat curtailed conditions, during which advantage was taken by all the operating companies to make extraordinary repairs in their different working shafts, whereby compressed air was substituted for steam as the power used for the hoisting engines. This change and the consolidation of several properties are said to have lowered copper costs at Butte in 1911. The number of electrically driven motors for hauling ore on the various levels underground in these mines is gradually being increased. These motors are doing the work formerly done by horses. The Washoe sampling works, which were destroyed by fire in 1910, were rebuilt during 1911 at a cost of $100,000. The new plant is of all-steel and concrete construction, equipped with the Brunton automatic sampling system for 500 tons of ore every 8-hour shift. The Butte, Anaconda & Pacific Railway completed plans for the electrification of the entire road from the mines at Butte to the Washoe Reduction Works at Anaconda and in addition contemplates the extension of its road from Anaconda [1] to the Georgetown district in Deer Lodge County, where are located several mines from which it is impossible for the owners at the present time to ship the lower grade ores on account of lack of transportation facilities. Some of the ores mined in the districts which will be tributary to the extension of the road are most desirable at the Anaconda smelter, and negotiations were concluded for the purchase by the Anaconda Copper Mining Co. of the Southern Cross mine, which has in the past been one of the largest producers. Mines in the Radersburg district are to be benefited

[1] Under construction in 1912.

by a branch line, which has been projected from the main line of the Northern Pacific Railway.

*Mine production of gold, silver, copper, lead, and zinc in Montana in 1911, by counties.*

| County. | Gold. | | | | Silver. | |
|---|---|---|---|---|---|---|
| | Placers. | | Deep mines. | | | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | *Fine oz.* | | *Fine oz.* | | *Fine oz.* | |
| Beaverhead | 70.39 | $1,455 | 2,099.47 | $43,400 | 102,864 | $54,518 |
| Broadwater | 247.82 | 5,123 | 29,050.11 | 600,519 | 13,387 | 7,095 |
| Cascade | | | 134.19 | 2,774 | 99,825 | 52,907 |
| Chouteau | 2.90 | 60 | 20,983.92 | 433,776 | 48,519 | 25,715 |
| Deer Lodge | 13.79 | 285 | 3,241.03 | 66,998 | 73,842 | 39,136 |
| Fergus | 3.19 | 66 | 17,343.17 | 358,515 | 8,676 | 4,598 |
| Gallatin | 20.51 | 424 | | | 1 | 1 |
| Granite | 125.00 | 2,584 | 6,620.41 | 136,856 | 350,852 | 185,952 |
| Jefferson | 208.88 | 4,318 | 4,439.67 | 91,776 | 823,704 | 436,563 |
| Lewis and Clark | 1,292.97 | 26,728 | 11,211.24 | 231,757 | 57,583 | 30,519 |
| Lincoln | 183.24 | 3,788 | 251.99 | 5,209 | 15,032 | 7,967 |
| Madison | 28,296.86 | 584,948 | 13,324.46 | 275,441 | 102,357 | 54,249 |
| Meagher | 1.84 | 38 | 4.30 | 89 | 92 | 49 |
| Missoula | 986.61 | 20,395 | 701.44 | 14,500 | 2,588 | 1,372 |
| Park | 108.12 | 2,235 | 27.81 | 575 | 264 | 140 |
| Powell | 1,129.22 | 23,343 | 1,778.84 | 36,772 | 25,659 | 13,599 |
| Ravalli | 137.19 | 2,836 | 41.31 | 854 | 959 | 508 |
| Sanders | | | 11.08 | 229 | 870 | 461 |
| Silver Bow | 298.72 | 6,175 | 35,107.18 | 725,730 | 10,258,122 | 5,436,805 |
| Total | 33,127.25 | 684,801 | 146,371.62 | 3,025,770 | 11,985,196 | 6,352,154 |

*Mine production of gold, silver, copper, lead, and zinc in Montana in 1911, by counties.*

| County. | Copper. | | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | *Pounds.* | | |
| Beaverhead | 137,577 | $17,197 | 830,572 | $37,376 | | | $153,946 |
| Broadwater | 140,558 | 17,570 | 149,276 | 6,717 | | | 637,024 |
| Cascade | 5,314 | 664 | 861,613 | 38,773 | | | 95,118 |
| Chouteau | | | | | | | 459,551 |
| Deer Lodge | 7,463 | 933 | | | | | 107,352 |
| Fergus | | | 17,446 | 785 | 75,995 | $4,332 | 368,296 |
| Gallatin | | | | | | | 425 |
| Granite | 16,627 | 2,078 | 80,679 | 3,630 | | | 331,100 |
| Jefferson | 161,719 | 20,215 | 2,088,236 | 93,971 | | | 646,843 |
| Lewis and Clark | 7,402 | 925 | 116,146 | 5,227 | | | 295,156 |
| Lincoln | | | 816,211 | 36,729 | | | 53,693 |
| Madison | 25,533 | 3,192 | 225,416 | 10,144 | | | 927,974 |
| Meagher | 10,862 | 1,358 | 12,544 | 564 | | | 2,098 |
| Missoula | | | 28,979 | 1,304 | | | 37,571 |
| Park | | | 29,866 | 1,344 | | | 4,294 |
| Powell | 41,468 | 5,183 | 110,796 | 4,986 | | | 83,883 |
| Ravalli | 7,053 | 882 | 24,372 | 1,097 | | | 6,177 |
| Sanders | 14,958 | 1,870 | 22,150 | 997 | | | 3,557 |
| Silver Bow | 272,271,171 | 34,033,896 | 1,017,273 | 45,777 | 43,734,150 | 2,492,846 | 42,741,229 |
| Total | 272,847,705 | 34,105,963 | 6,431,575 | 289,421 | 43,810,145 | 2,497,178 | 46,955,287 |

*Quantity of ore sold or treated, number of mines producing, and average value per ton of ores in Montana in 1910 and 1911, by counties.*

| County. | Ore sold or treated. | | Number of deep mines producing. | | Average value per ton.[a] | | Average value per ton in gold and silver.[a] | |
|---|---|---|---|---|---|---|---|---|
| | 1911 | Increase (+) or decrease (−). | 1910 | 1911 | 1910 | 1911 | 1910 | 1911 |
| | *Short tons.* | *Short tons.* | | | | | | |
| Beaverhead | 2,155 | + 1,163 | 19 | 11 | $103.71 | $70.76 | $83.97 | $45.44 |
| Broadwater | 27,772 | + 12,889 | 27 | 27 | 23.84 | 22.75 | 22.05 | 21.88 |
| Cascade | 2,962 | + 1,581 | 12 | 10 | 35.08 | 32.10 | 23.88 | 18.80 |
| Chouteau | 69,493 | + 13,153 | 2 | 2 | 9.38 | 6.61 | 9.38 | 6.61 |
| Deer Lodge | 5,656 | + 52 | 14 | 13 | 26.94 | 18.93 | 26.83 | 18.76 |
| Fergus | 98,546 | − 47,201 | 8 | 6 | 4.43 | 3.74 | 4.40 | 3.68 |
| Flathead | ..... | − 26 | 1 | ..... | 93.31 | ..... | 4.50 | ..... |
| Granite | 9,357 | + 2,612 | 28 | 32 | 35.52 | 35.11 | 35.00 | 34.50 |
| Jefferson | 69,614 | + 12,343 | 53 | 76 | 13.75 | 9.23 | 11.96 | 7.59 |
| Lewis and Clark | 43,850 | − 1,660 | 62 | 43 | 4.81 | 6.12 | 4.61 | 5.98 |
| Lincoln | 4,642 | + 4,352 | 5 | 4 | 10.98 | 10.75 | 6.90 | 2.84 |
| Madison | 28,765 | − 2,956 | 82 | 111 | 13.29 | 11.84 | 12.79 | 11.38 |
| Meagher | 67 | + 16 | 2 | 3 | 33.90 | 30.75 | 2.19 | 2.06 |
| Missoula | 4,527 | + 2,809 | 3 | 3 | 6.54 | 3.79 | 4.17 | 3.50 |
| Park | 58 | − 95 | 2 | 3 | 52.42 | 35.31 | 9.72 | 12.14 |
| Powell | 2,536 | + 1,473 | 14 | 19 | 32.70 | 23.84 | 21.18 | 19.83 |
| Ravalli | 225 | + 169 | 2 | 1 | 85.91 | 14.83 | 41.77 | 6.03 |
| Sanders | 136 | − 330 | 4 | 3 | 25.40 | 26.15 | 8.56 | 5.07 |
| Silver Bow | 4,569,942 | −139,487 | 83 | 63 | 9.38 | 9.35 | 1.35 | 1.35 |
| Total | 4,940,303 | −139,143 | 423 | 430 | 9.41 | 9.36 | 1.91 | 1.90 |

[a] Placer product excluded.

*Number of producing mines, classified by chief products, in Montana in 1911, by counties.*

| County. | Placer mines. | | | Deep mines. | | | | | | | | | | | Total producing mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hydraulic. | Dredge. | Drift. | Gold. | Copper. | Gold-silver. | Gold-copper. | Gold-silver-copper. | Gold-silver-copper-lead. | Gold-silver-lead. | Silver-copper-lead. | Silver-lead. | Silver-copper. | Silver-lead-zinc. | |
| Beaverhead | 4 | .... | .... | .... | .... | 2 | .... | 1 | 7 | 1 | .... | .... | .... | .... | 15 |
| Broadwater | 12 | .... | .... | .... | .... | 3 | 1 | 6 | 4 | 13 | .... | .... | .... | .... | 39 |
| Cascade | ..... | .... | .... | .... | .... | 1 | .... | ..... | 2 | 6 | .... | 1 | .... | .... | 10 |
| Chouteau | 1 | .... | .... | .... | .... | 2 | .... | ..... | .... | ..... | .... | .... | .... | .... | 3 |
| Deer Lodge | 1 | .... | .... | .... | .... | 8 | .... | 4 | .... | ..... | .... | .... | 1 | .... | 14 |
| Fergus | 1 | .... | .... | .... | .... | 5 | .... | ..... | .... | ..... | .... | .... | .... | [a] 1 | 7 |
| Gallatin | 1 | .... | .... | .... | .... | ..... | .... | ..... | .... | ..... | .... | .... | .... | .... | 1 |
| Granite | 7 | .... | .... | .... | .... | 13 | .... | 11 | 5 | 2 | .... | .... | 1 | .... | 39 |
| Jefferson | 16 | .... | .... | .... | .... | 21 | .... | 12 | 15 | 21 | 1 | 4 | 2 | .... | 92 |
| Lewis and Clark | 35 | 1 | .... | 4 | .... | 19 | 1 | 3 | 6 | 9 | .... | 1 | .... | .... | 79 |
| Lincoln | 3 | .... | .... | .... | .... | 1 | .... | ..... | .... | 3 | .... | .... | .... | .... | 7 |
| Madison | 16 | 1 | .... | .... | .... | 41 | .... | 29 | 13 | 28 | .... | .... | .... | .... | 128 |
| Meagher | 1 | .... | .... | .... | .... | 1 | .... | 1 | .... | .... | 1 | .... | .... | .... | 4 |
| Missoula | 27 | 2 | .... | .... | .... | 2 | .... | ..... | .... | ..... | .... | 1 | .... | .... | 32 |
| Park | 5 | .... | 1 | .... | .... | 2 | .... | ..... | .... | 1 | .... | .... | .... | .... | 9 |
| Powell | 27 | 1 | .... | 1 | .... | 5 | .... | 5 | 3 | 5 | .... | .... | .... | .... | 47 |
| Ravalli | 7 | .... | .... | .... | .... | ..... | .... | ..... | 1 | ..... | .... | .... | .... | .... | 8 |
| Sanders | ..... | .... | .... | .... | .... | ..... | .... | 2 | 1 | ..... | .... | .... | .... | .... | 3 |
| Silver Bow | 9 | .... | 1 | 1 | 1 | 21 | .... | 32 | [b] 7 | .... | 1 | .... | .... | .... | 73 |
| Total | 173 | 5 | 2 | 6 | 1 | 147 | 2 | 106 | 64 | 89 | 3 | 7 | 4 | 1 | 610 |

[a] Contains no silver.

[b] Two contain zinc also.

## PRODUCTION BY COUNTIES.

### BEAVERHEAD COUNTY.

*Mine production of gold, silver, copper, and lead in Beaverhead County, Mont., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 2,762.46 | $57,105 | 2,169.86 | $44,855 | − 592.60 | −$12,250 |
| Silver.....do.... | 51,649 | 27,890 | 102,864 | 54,518 | + 51,215 | + 26,628 |
| Copper.....pounds.. | 59,313 | 7,533 | 137,577 | 17,197 | + 78,264 | + 9,664 |
| Lead.....do.... | 273,985 | 12,055 | 830,572 | 37,376 | +556,587 | + 25,321 |
| Total..... | ..... | 104,583 | ..... | 153,946 | ..... | + 49,363 |

Reports from 11 deep mines and 4 placers in 1911 showed a metallic production contained in bullion and 2,155 tons of ore valued at $153,946. All the ore produced was shipped directly to the smelters and contained $43,400 in gold, 102,859 ounces of silver, 133,577 pounds of copper, and 830,572 pounds of lead, valued in all at $152,488, or an average of $70.76 per ton. The county output was 1,163 tons greater in 1911 than was mined by 19 operators in 1910. Copper-lead ore predominated and contained 44.30 ounces of gold, 90,480 ounces of silver, 98,126 pounds of copper, and 766,883 pounds of lead. Copper ore produced aggregated 149 tons, lead ore, 69 tons; and dry or siliceous ore, 842 tons, carrying gold and silver and small quantities of copper and lead. The placer yield contained $1,455 in gold and 5 ounces of silver.

*Bannack district.*—Shipments of ore to smelters aggregated 839 tons, produced from 4 deep mines, which contained $42,340 in gold, 6,886 ounces of silver, 3,013 pounds of copper, and 38,349 pounds of lead, in all valued at $48,093, or an average of $57.32 per ton. Operators of placers reported from 3 sources the production of $1,144 in gold and 3 ounces of silver. The largest production of lead-silver ore carrying good values in gold and a little copper was made from the Excelsior, Wadams, and Golden Reef properties.

*Big Hole district.*—In Colorado Gulch, in the Horse Prairie section, some placer gold was recovered by sluicing. The gold fineness was about 0.882.

*Blue Wing district.*—The operator of 1 deep mine reported the production of silver ore containing copper and lead.

*Bryant district.*—The ore output of the district was all shipped crude and contained principally lead and silver and some gold and copper. The Atlantis and True Fissure property was operated during the entire year. This mine is opened by a 400-foot incline shaft. The Cleopatra, Ariadne, Trapper, and Cleve mines at Hecla produced carbonate lead ores. The entire production from the district aggregated 1,095 tons.

*Nogo district.*—Carbonate lead ore carrying considerable values in silver, a little gold, and some copper was produced from the Millionaire property.

*Utopia district.*—Copper ore carrying a little silver and gold was shipped by lessees from the Indian Queen property. This property is opened by a vertical shaft 200 feet deep and has 600 feet of drifts. There is a 50-ton blast furnace on the property which has not been in operation for several years.

## BROADWATER COUNTY.

*Mine production of gold, silver, copper, and lead in Broadwater County, Mont., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 15,574.58 | $321,955 | 29,297.93 | $605,642 | +13,723.35 | +$283,687 |
| Silver.....do.... | 21,480 | 11,600 | 13,387 | 7,095 | − 8,093 | − 4,505 |
| Copper.....pounds.. | 124,938 | 15,867 | 140,558 | 17,570 | +15,620 | + 1,703 |
| Lead.....do.... | 245,935 | 10,821 | 149,276 | 6,717 | −96,659 | − 4,104 |
| Total..... | ..... | 360,243 | ..... | 637,024 | ..... | + 276,781 |

The output of ore by 27 deep-mine operators in 1911, the same number reporting in 1910, was 27,722 tons, which is 12,889 tons greater than was mined in 1910. The total average value per ton decreased from $23.84 in 1910 to $22.75 in 1911 and the gold and silver value in this ore from $22.05 to $21.88. Nearly all of the ore was iron sulphide, valuable as a flux, and for its gold content was shipped crude to the smelters. It aggregated 27,768 tons, and contained $597,564 in gold, 13,251 ounces of silver, 140,531 pounds of copper, and 149,276 pounds of lead, valued in all at $628,870, or an average of $22.65 per ton. A small quantity of ore was treated at an amalgamation mill, yielding gold and silver bullion and concentrates, containing principally gold with a small amount of silver and copper. The amalgamated ore was selected from small knife-blade veins and averaged $651.25 per ton in gold and silver. The concentrates produced at the same property yielded $407 per ton in gold and silver. The placers yielded $5,123 in gold and 33 ounces of silver.

*Backer or Diamond City district.*—Rich seams or pockets of gold quartz mined from the Slim Jim property furnished the larger part of the gold and silver produced in the district. The property is opened by 7 adits, the longest of which is 450 feet and the deepest vertical shaft is 175 feet. The 1-stamp mill equipped with plates was capable of treating 3 tons per day of 24 hours.

*Beaver district.*—Ten deep mines yielded ore, shipped directly to the smelters, aggregating 2,954 tons, which contained $106,228 in gold, 10,853 ounces of silver, 4,035 pounds of copper, and 100,936 pounds of lead, valued in all at $117,027, or an average of $39.62 per ton. The principal producer was the East Pacific mine, yielding lead-silver ore containing values in gold and copper. The Cynosure mine produced auriferous and argentiferous sulphide ore. The property is opened by an adit 350 feet long. Gold ore carrying a little lead and silver was shipped from the Iron Cap property, which is

opened by an adit 400 feet in length. The Black Friday and Martha Washington properties were also producers. The latter is developed by a vertical shaft 250 feet deep and has 1,500 feet of drifts and adits aggregating 1,000 feet.

*Cedar Plains district.*—Ore was produced from 5 properties, aggregating 24,627 tons, containing $486,454 in gold, 662 ounces of silver, 135,674 pounds of copper, and 8,064 pounds of lead, valued in all at $504,127, or an average value of $20.47 per ton. There were 2 placer productions amounting to $510 in gold and 2 ounces of silver. The Keating group was the largest producer, supplying to the smelters an auriferous iron sulphide ore carrying 35 to 40 per cent of iron and 10 to 20 per cent of silica. A vertical shaft on this property is 400 feet deep, with an incline shaft 600 feet deep and 7,000 feet of drifts. The Ohio produced ore similar to that from the Keating mine. This property is opened by a vertical shaft 300 feet deep. One mile from Radersburg, the principal camp in the district, stream and gravel deposits were operated by hydraulic methods, yielding gold with an average fineness of 0.893. A branch of the Northern Pacific Railway into the district is under construction and is expected to be completed in 1912.

*Park district.*—Shipping ore only was produced from 11 deep mines and aggregated 187 tons, containing $4,882 in gold, 1,736 ounces of silver, 822 pounds of copper, and 40,276 pounds of lead, valued in all at $7,717, or an average of $41.27 per ton. The placer bullion output, reported by 9 operators, contained $4,540 in gold and 31 ounces of silver. Auriferous iron sulphide ore, carrying some lead, was shipped from the Florence property. Oxidized iron ore, containing gold, was produced from the Little Giant property, which is opened by 3,363 feet of adits. Lead ore, containing considerable values in gold and silver, was shipped from the Clark mine, which is developed by a vertical shaft 100 feet deep and 30 feet of drifts.

## CASCADE COUNTY.

*Mine production of gold, silver, copper, and lead in Cascade County, Mont., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 104.97 | $2,170 | 134.19 | $2,774 | + 29.22 | + $604 |
| Silver.....do.... | 57,060 | 30,812 | 99,825 | 52,907 | + 42,765 | +22,095 |
| Copper.....pounds.. | 18,415 | 2,339 | 5,314 | 664 | − 13,101 | − 1,675 |
| Lead.....do.... | 298,489 | 13,134 | 861,613 | 38,773 | +563,124 | +25,639 |
| Total..... | ..... | 48,455 | ..... | 95,118 | ..... | +46,663 |

Ten producers mined 2,962 tons of ore in 1911, which is 1,581 tons greater than was mined by 12 operators in 1910. The total average value of the ore decreased from $35.08 in 1910 to $32.10 in 1911, and the gold and silver value from $23.88 to $18.80 per ton. Nearly all of the ore (2,398 tons) was shipped crude and contained $2,324 in gold, 95,047 ounces of silver, 4,784 pounds of copper, and 745,693 pounds of lead, valued in all at $86,853, or an average of $36.22 per

ton. There were 414 tons of ore treated at concentrating mills, yielding 138 tons of concentrate, which contained $86 in gold, 4,416 ounces of silver, 530 pounds of copper, and 115,920 pounds of lead, valued in all at $7,708, or an average of $55.86 per ton.

*Montana district.*—Ten deep mines yielded 2,962 tons of ore, containing $2,774 in gold, 99,825 ounces of silver, 5,314 pounds of copper, and 861,613 pounds of lead, having a total value of $95,118, or an average value of $32.11 per ton. The larger part of the ore was of shipping grade and contained $2,324 in gold, 95,047 ounces of silver, 4,784 pounds of copper, and 745,693 pounds of lead. There were also 414 tons of ore treated at a concentration mill, yielding 138 tons of lead concentrates; and 150 tons of ore were treated by the cyanide process. The largest amount of lead-silver ores, carrying copper and a small amount of gold, was produced from the Barker mine. Other producers were the Big Seven, Broken Hill, Broadwater, Benton, Queen of the Hills, Ripple, I X L, and Spokane.

### CHOUTEAU COUNTY.

Gold and silver only were produced in this county in 1911, and aggregated in value $459,551, as against a yield valued at $528,643 in 1910 and at $704,135 in 1909. The Ruby Gulch and the August mines in the Little Rockies were the only producers in the county. Each property is equipped with large cyanide plants.

### DEER LODGE COUNTY.

Ore aggregating 5,656 tons was mined by 13 producers in 1911, which is 52 tons more than was mined by 14 operators in 1910. The total average value per ton decreased from $26.94 in 1910 to $18.93 in 1911, and the gold and silver value in this ore from $26.83 to $18.76 per ton. The total output of deep mines and placers yielded $67,283 in gold, 73,842 ounces of silver, and 7,463 pounds of copper, valued in all at $107,352. The larger part, or 3,299 tons, was treated at cyanide mills, yielding 1,101.09 ounces of gold and 338 ounces of silver, valued in all at $22,940, or an average of $6.95 per ton. The remainder of the ore produced, aggregating 2,357 tons, was shipped directly to smelters, yielding $44,235 in gold, 73,503 ounces of silver, and 7,463 pounds of copper, valued in all at $84,125, or an average of $35.69 per ton. The placer bullion mined by one producer yielded $285 in gold and 1 ounce of silver. The mine output was classified as dry or siliceous ore.

*Georgetown district.*—The output of 11 deep mines amounted to 5,652 tons of ore, containing $66,826 in gold, 73,736 ounces of silver, and 7,413 pounds of copper, having a total value of $106,832, or an average of $18.91 per ton. The greater part, or 3,299 tons, was treated at cyanide mills, and 2,353 tons were shipped directly to smelters. At the Southern Cross mine part of the second-class ore dump was treated in a cyanide mill, which is equipped with Chilean mills, cyanide tanks, Dorr classifiers, and Moore filters for the ordinary leaching of the crushed ore. The property has been sold to the Anaconda Copper Mining Co., which will extend the railroad to the mine and smelt the ores at its smelter near Anaconda. The Oro Fino mine, which was operated by lessees, was the next largest producer

of oxidized gold ores. This property is developed by a vertical shaft 200 feet deep. The Holdfast property also made an important output. The mine is developed by a shaft 130 feet deep. Silver ore was shipped from the Extension property at Silver Lake.

## FERGUS COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Fergus County, Mont., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 30,802.88 | $636,752 | 17,346.36 | $358,581 | −13,456.52 | −$278,171 |
| Silver.....do.... | 9,283 | 5,013 | 8,676 | 4,598 | − 607 | − 415 |
| Copper.....pounds.. | 1,167 | 148 | ..... | ..... | − 1,167 | − 148 |
| Lead.....do.... | 60,254 | 2,651 | 17,446 | 785 | − 42,808 | − 1,866 |
| Zinc.....do.... | 18,000 | 972 | 75,995 | 4,332 | + 57,995 | + 3,360 |
| Total..... | ..... | 645,536 | ..... | 368,296 | ..... | − 277,240 |

Six deep mines in Fergus County produced 98,546 tons of ore, which is 47,201 tons less than was mined from 8 properties in 1910. The total average value per ton decreased from $4.43 in 1910 to $3.74 in 1911, and the gold and silver value from $4.40 to $3.68 per ton. The greater part of the mine output, or 98,331 tons, was milled and the gold and silver values extracted by cyanidation, producing bullion containing 16,465.18 ounces of gold and 6,366 ounces of silver, valued at $343,740, or an average of $3.50 per ton. Some concentrate was produced from this ore, which yielded gold and silver valued at $14,319. The crude ore shipped to smelters, amounting to 215 tons, contained 226.39 fine ounces of gold, 706 ounces of silver, 17,446 pounds of lead, and 75,995 pounds of zinc, valued in all at $10,171, or an average of $47.31 per ton. Only one placer operator reported production.

*North Moccasin district.*—The principal output of gold was made from the Kendall mine. The property is opened by a vertical shaft 640 feet deep. A large amount of development work was done in 1911. The oxidized zone is said to extend to a depth of 600 feet. The ore mined was treated in a 500-ton cyanide plant.

*Warm Springs district.*—Operators of 4 properties shipped 55,944 tons of ore containing $163,116 in gold, 7,538 ounces of silver, 17,446 pounds of lead, and 75,995 pounds of zinc, having a total value of $172,228, or an average recovery of $3.08 per ton. The largest part of this output was treated at cyanide mills, one of which was equipped for concentration, and some gold and silver concentrate was shipped. There were also 212 tons of ore shipped containing lead and zinc. The principal production of ore was made from the Cumberland property, which is opened by an adit 750 feet long. A 150-ton cyanide plant was operated by lessees during the latter part of the year. The Gold Leaf property produced oxidized ores, which are said to extend to a depth of 200 feet. The baser grades of ore are not treated. The ores are treated in a 300-ton cyanide plant. The Maginnis property, operated under lease, is opened by a vertical

shaft 200 feet deep and has 6,000 feet of drifts. The basic oxidized ores, carrying a little lead, predominate. The oxidized ores are said to extend to a depth of 500 feet. The mine was operated the entire year and the mill was started in April. It has 10 stamps and is equipped with concentrating and cyaniding apparatus. The treatment of the ore is through stamps and Huntington mills over tables. The crushed ore is classified, the slimes are agitated, and sands are leached in cyanide solution. The 150-ton cyanide mill of the New Year property was entirely reconstructed after being idle seven years. Some ore mined in 1911 was treated, but a clean-up of the product was not made until 1912. The War Eagle produced some carbonate lead-zinc ore, which was shipped to an eastern plant.

### GALLATIN COUNTY.

The entire production consisted of gold and silver bullion produced from one placer in the county.

*Springhill district.*—The West Fork placers were operated, yielding gold bullion 0.952 in fineness.

### GRANITE COUNTY.

*Mine production of gold, silver, copper, and lead in Granite County, Mont., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 3,891.43 | $80,443 | 6,745.41 | $139,440 | +2,853.98 | +$58,997 |
| Silver.....do.... | 308,423 | 166,548 | 350,852 | 185,952 | + 42,429 | + 19,404 |
| Copper.....pounds.. | 18,867 | 2,396 | 16,627 | 2,078 | − 2,240 | − 318 |
| Lead.....do.... | 26,321 | 1,158 | 80,679 | 3,630 | + 54,358 | + 2,472 |
| Total..... | ..... | 250,545 | ..... | 331,100 | ..... | + 80,555 |

Thirty-two producers mined 9,357 tons of ore in 1911, which is 2,612 tons more than was reported by 28 producers in 1910. The total average value per ton decreased from $35.52 in 1910 to $35.11 in 1911, and the gold and silver value from $35 to $34.50. Most of the mine output was shipped directly to the smelters and amounted to 7,463 tons of ore, containing $115,181 in gold, 350,351 ounces of silver, 16,627 pounds of copper, and 80,679 pounds of lead, valued in all at $306,575, or an average of $41.08 per ton. At milling plants 1,339 tons of ore were treated from which were extracted 39.11 ounces of gold and 46 ounces of silver by amalgamation, and 889.61 ounces of gold and 284 ounces of silver by cyanidation. This bullion was valued in all at $19,373, or an average of $14.47 per ton. There were also some concentrates produced from the same ore that produced the bullion and contained only gold and silver. The placer bullion reported by 7 producers contained $2,584 in gold and 11 ounces of silver.

*Alps district.*—The Rainy Day property, situated on Harvey Creek, produced some gold ore. The prospect is opened by a surface drift 75 feet long.

*First Chance district.*—Seven deep mines yielded 1,271 tons of ore, of which that of shipping grade, aggregating 1,175 tons, contained $73,204 in gold, 4,913 ounces of silver, and 3,658 pounds of copper. At amalgamation mills 96 tons of ore were treated, yielding some gold bullion, and concentrate containing gold and silver. Four placer operators reported $1,876 in gold and 7 ounces of silver. The Magone & Anderson property, which was in the hands of new owners, made an important production of ore carrying gold, silver, and a little copper. The gold practically equals the silver, ounce for ounce, in the ore. The Nancy Hanks, San Jose, Shamrock, and Dewey properties also produced gold and silver ore. In Bear Gulch, the Fealand placer was operated about four months and yielded gold having an average fineness of 0.910. The stream gravels of Elk Creek were also productive of gold by sluicing, averaging in fineness about 0.900. The placers situated on the tributaries of Ten Mile Gulch yielded a small amount of gold.

*Flint Creek district.*—Ore aggregating 5,490 tons was mined by 15 operators. The larger part of the ore was shipped and the remainder treated by the cyanide process. The total metallic content of the ore was $14,460 in gold, 343,558 ounces of silver, 12,690 pounds of copper, and 80,679 pounds of lead, valued in all at $201,762, or an average of $36.75 per ton. The largest part of the output consisted of silver ore, carrying values in gold and a little copper and lead, and was shipped from the Granite Bi-Metallic mines, upon which a large amount of development work was done in 1911. The Hope mine produced a similar class of ore. Lead-silver ore, with fair values in gold and a little copper, was mined from the Hobo group. This ore is said to contain zinc also. The Pocahontas claim yielded lead-silver ore and some silver ore was shipped from the Two Per Cent property.

*Red Lion district.*—The Hidden Lake mine, the principal producer, was operated continuously during 1911, and oxidized iron ores, carrying gold and a little silver, were shipped to the Doherty mill, 2 miles from the mine, where they were crushed in a cyanide solution and the slimes and sands were treated separately. The mine is opened by an adit 280 feet long and has 200 feet of drifts.

*Rock Creek district.*—The Basin placers, the most extensive holdings in Eureka Gulch, were reported idle during 1911. A production was reported by small operators in the district.

*South Boulder district.*—Operators of seven mines produced 104 tons of ore, which was shipped directly to the smelters; and 49 tons of ore and 500 tons of old tailings were treated at cyanide mills. A small lot of gold and silver concentrate was also produced. The total metallic output of the district contained $6,873 in gold, 2,030 ounces of silver, and 279 pounds of copper, valued in all at $7,984, or an average of $12.23 per ton. At the Sunday property, which is opened by an adit 1,200 feet long, the ore was treated in a Huntington mill and 25-ton leaching plant. Besides considerable values in gold, the ore contains a little silver and about 1 per cent of copper. At the North Star property a 100-ton copper leaching and precipitating plant was under construction.

## JEFFERSON COUNTY.

*Mine production of gold, silver, copper, and lead in Jefferson County, Mont., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 6,468.17 | $133,709 | 4,648.55 | $96,094 | −1,819.62 | −$37,615 |
| Silver.....do.... | 1,029,579 | 555,972 | 823,704 | 436,563 | − 205,875 | −119,409 |
| Copper.....pounds.. | 122,109 | 15,508 | 161,719 | 20,215 | + 39,610 | + 4,707 |
| Lead.....do.... | 1,975,492 | 86,922 | 2,088,236 | 93,971 | + 112,744 | + 7,049 |
| Total..... | ..... | 792,111 | ..... | 646,843 | ..... | − 145,268 |

The reports of 76 producers show that 69,614 tons of ore were mined, which is 12,343 tons greater than was produced from 53 mines in 1910. The total average value per ton decreased from $13.75 in 1910 to $9.23 in 1911, and the gold and silver value of this ore from $11.96 to $7.59. Concentration mills treated the bulk of the ore produced, or 41,781 tons, which yielded 1,493 tons of concentrate, containing $4,670 in gold, 145,360 ounces of silver, 2,023 pounds of copper, and 353,520 pounds of lead, valued in all at $97,872, or an average of $65.55 per ton. The smelting ores produced amounted to 27,049 tons, containing $83,809 in gold, 677,980 ounces of silver, 159,696 pounds of copper, and 1,734,716 pounds of lead, valued in all at $541,162, or an average of $20.01 per ton. The ores treated by amalgamation yielded from 784 tons, 159.49 ounces of gold and 325 ounces of silver, valued in all at $3,469, or an average of $4.42 per ton. The ores mined were largely dry or siliceous and aggregated 66,232 tons, containing 3,846.11 ounces of gold, 751,136 ounces of silver, 57,979 pounds of copper, and 1,542,093 pounds of lead. The copper ore aggregated 1,132 tons and the lead ore 2,250 tons. The placer production reported by 16 operators contained $4,318 in gold and 39 ounces of silver, having a total value of $4,339, as against a total value of $4,526 in 1910 and of $5,966 in 1909.

*Amazon district.*—All of the ore mined, or 212 tons, produced by 3 operators, was shipped to the smelters and contained $3,136 in gold, 3,284 ounces of silver, 5,677 pounds of copper, and 22,176 pounds of lead, valued in all at $6,585, or an average of $31.06 per ton. The Baltimore mine was the largest producer and was operated by lessees.

*Boulder district.*—Three deep mines yielded 65 tons of ore of shipping grade containing $198 in gold, 810 ounces of silver, 439 pounds of copper, and 18,174 pounds of lead, valued in all at $1,501, or an average value of $23.09 per ton. Placer bullion reported by 3 operators contained $534 in gold and 5 ounces of silver.

*Cataract and Lowland district.*—Ore produced from 20 deep mines aggregated 2,052 tons, and contained $10,456 in gold, 22,903 ounces of silver, 5,208 pounds of copper, and 226,915 pounds of lead, valued in all at $33,458, or an average of $16.31 per ton. Most of the ore produced, or 1,268 tons, was of shipping grade and contained all of the lead and copper and a large part of the silver. The remainder, or 784 tons, was treated at amalgamation mills. A large part of the ore was mined from the Comet and Crystal properties, and most of

it was shipped to the smelters by lessees. The remainder is awaiting treatment at the plant of the Northwestern Metals Co., near Helena, but no record of the metal content will be made until the plant is started and the first test completed. The Comet property is opened by a vertical shaft 975 feet deep. The oxidized ore extends to a depth of 60 feet, and that of shipping grade is sulphide with a siliceous gangue, carrying gold, silver, copper, lead, zinc, manganese, and iron. A small quantity of sulphide lead ore was shipped from the Morning Star property, in which the oxidized ore zone is said to extend 40 feet in depth. The Ruby and Columbia mines are opened to a depth of 400 feet by a vertical shaft, 500 feet of drifts, and an adit 2,400 feet long, and were productive of siliceous gold-silver ore. The oxidized ores extend to a depth of about 300 feet. A 10-stamp mill equipped for amalgamation and concentration was operated on dump material from the Ruby mine during the month of October and produced bullion and concentrate. The latter was not shipped. The St. John, Sirius, Jennie, Emma B., Bonanza Jack, Kit Carson, and Corbet properties were also producers.

*Colorado district.*—The ore produced from 13 deep mines aggregated 1,973 tons. All of this, with the exception of 30 tons treated by concentration, was shipped directly to the smelters. The total output of ore contained $4,563 in gold, 49,842 ounces of silver, 96,257 pounds of copper, and 227,377 pounds of lead, valued in all at $53,243, or an average of $26.99 per ton. The placer output amounted to $105 in gold and 2 ounces of silver. The largest production was from the Blue Bird property, at Corbin, and consisted of sulphide copper ores, which were shipped directly to the smelter. The property is opened by a vertical shaft 1,000 feet deep, 4,146 feet of drifts, and an adit tunnel 2,320 feet long. Oxidized lead ore, carrying considerable silver values and a small amount of gold and copper was shipped by lessees working on the surface of the Alta-Gregory properties. The Blizzard claim, which is opened by an adit 1,100 feet long, was operated under lease and produced some lead ore carrying silver, gold, and a little copper. Ore of the same character was shipped from the Surprise and Euberta claims, which are developed by an incline shaft sunk to a depth of 291 feet. From the Corbin mine some lead and copper ores were shipped as tests taken out in the development of the property. A new 100-ton concentration mill was under construction during the year. Several other properties were worked by lessees and the returns are included in the district totals. The Lost Cabin gulch placers, about 7 miles northwest of Wickes, were operated by hydraulicking and sluicing, and produced a small quantity of bullion.

*Elkhorn district.*—Ten properties yielded an output of 64,625 tons of ore, containing $59,287 in gold, 738,691 ounces of silver, 51,892 pounds of copper, and 1,547,608 pounds of lead, valued in all at $526,923, or an average of $8.15 per ton. The greater part, or 41,751 tons, was concentrated, yielding lead-silver concentrate, containing small quantities of gold and copper. There were 22,874 tons of lead-silver ore shipped directly to the smelter, containing small values in copper and gold. The principal property producing in 1911 was the Elkhorn mine, which is opened by a shaft 2,300 feet deep. The largest part of the ore mined was treated in a concentration mill, yielding concentrates containing lead, silver, gold, and a little copper. The crude ores of shipping grade contained the same metals with con-

siderable values in gold and silver. The Golden Curry was operated during the entire year, part of the time under lease, and produced a low-grade gold-copper-iron fluxing ore. The property is opened by 3 adits, the longest of which is 1,400 feet and is being equipped with a cyanide mill which will have a capacity of 100 tons per day. The Park claim is opened by a vertical shaft 35 feet deep and 50 feet of drifts. Oxidized iron ore, carrying small values in gold and silver, was shipped from this property. The Vestal, Montezuma, Tacoma, Two Sons, and Peacock properties were also operated.

*Homestake district.*—This district is located 9½ miles southeast of Butte and is reached from Homestake on the Northern Pacific Railway. The output of 9 claims aggregated 107 tons of ore, which was shipped directly to the smelter and contained $3,064 in gold, 3,054 ounces of silver, and 129 pounds of copper, valued in all at $4,699, or an average of $43.92 per ton. The principal properties worked were the Hackensack, Orphan Boy, Nannie, Copper Blossom, and Nellie group, which produced high-grade silver ore.

*Lump Gulch district.*—Eight mines yielded 175 tons of ore of shipping grade, which contained $459 in gold, 3,882 ounces of silver, 2,117 pounds of copper, and 3,715 pounds of lead, valued in all at $2,947, or an average of $16.84 per ton. Some silver-lead ore was shipped from the Little Nell, Lone Star, and Rachael claims, and gold ore containing a little copper from the Frohlmer mine.

*McClellan Creek district.*—The Perseverance placers were operated a short time during 1911.

*Mitchell Gulch district.*—The district output made by 3 deep mines and 3 placers contained $3,751 in gold, 243 ounces of silver, and 552 pounds of lead, valued in all at $3,902. All of the ore mined was shipped directly to smelters. Placers yielded $2,007 in gold and 13 ounces of silver. Some ore was shipped from the Last Hope property, and the Young Brothers and Turner diggings, and two other placers produced placer gold.

*Whitehall and Little Pipestone districts.*—The operators of 5 deep mines and 1 placer yielded ore and bullion containing $9,139 in gold, 830 ounces of silver, and 41,706 pounds of lead, valued in all at $11,456. There were mined and shipped to smelters 286 tons of ore from the Columbia, Golden Sunlight, Gold King, and Carbonate properties.

## LEWIS AND CLARK COUNTY.

*Mine production of gold, silver, copper, and lead in Lewis and Clark County, Mont., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| PLACERS. | | | | | | |
| Gold.....fine ounces.. | 632.89 | $13,083 | 1,292.97 | $26,728 | + 660.08 | +$13,645 |
| Silver.....do.... | 99 | 53 | 179 | 95 | + 80 | + 42 |
| DEEP MINES. | | | | | | |
| Gold.....fine ounces.. | 8,602.04 | 177,820 | 11,211.24 | 231,757 | +2,609.20 | + 53,937 |
| Silver.....do.... | 58,894 | 31,803 | 57,404 | 30,424 | − 1,490 | − 1,379 |
| Copper.....pounds.. | 4,306 | 547 | 7,402 | 925 | + 3,096 | + 378 |
| Lead.....do.... | 196,883 | 8,663 | 116,146 | 5,227 | − 80,737 | − 3,436 |
| Total..... | ..... | 231,969 | ..... | 295,156 | ..... | + 63,187 |

Forty-three producers reported the treatment of 43,850 tons of ore and old tailings, which is 1,660 tons less than was reported by 62 producers in 1910. The total average value per ton of the material treated increased from $4.81 in 1910 to $6.12 in 1911, and the gold and silver value from $4.61 to $5.98. Gold and silver milling plants crushed the largest part of the mine output, or 36,993 tons of ore, which yielded bullion by the amalgamation process containing 8,107.85 ounces of gold and 14,344 ounces of silver. By cyanidation there were recovered 1,706.28 ounces of gold and 14,043 ounces of silver. The bullion recovered from ore and tailings had a total value of $217,920, or an average recovery of $5.89 per ton. There were also recovered from ore of 1 mine 58 tons of concentrate containing gold, silver, and lead. The crude ore shipped directly to smelters aggregated 1,211 tons and contained $27,632 in gold, 26,609 ounces of silver, 7,402 pounds of copper, and 114,459 pounds of lead, valued in all at $47,811, or an average of $39.48 per ton. Thirty-six placer producers reported in 1911, against 40 in 1910. The placer bullion contained $26,728 in gold and 179 ounces of silver, against $13,083 in gold and 99 ounces of silver in 1910. This large increase was due mainly to the activity of placers in the Dry Gulch district, where a dredge was in operation. The mine output was classified mainly as dry or siliceous ore, of which 46,322 tons were produced. In addition, there were 24 tons of copper ore and 504 tons of lead ore.

*Bald Butte district.*—The principal producer was the Strawberry mine, which is equipped with a 10-stamp amalgamation mill, yielding gold and silver bullion from sulphide ores. The property is opened by a vertical shaft 200 feet deep, with a crosscut about 1,100 feet long, and the drifting on the vein amounts to about 1,200 feet. During the year a drain tunnel was driven; the shaft was abandoned; and a new 10-stamp mill was completed.

*Dry Gulch district.*—The output of ore made by 4 operators aggregated 64 tons and contained $2,067 in gold, 244 ounces of silver, and 17,836 pounds of lead, valued in all at $2,999, or an average value of $46.86 per ton. Placers operated by 3 producers yielded $20,303 in gold and 125 ounces of silver. In 1910 the placer output was $5,477 in gold and 38 ounces of silver. Lead ore was shipped from the Lady Alice, Golden Cloud, Talisman, and Charm properties. Various placers were operated, the principal output coming from the dredging operations of the Magpie Development Co., which operated for 5½ months. The fineness of the gold in the district averages about 0.853.

*Gould district.*—Old tailings and ore, aggregating 10,958 tons, were treated during 1911, yielding gold and silver. The principal output was from the Gould mine, which is equipped with a 20-stamp amalgamation and cyanidation mill. The property is opened by a shaft 350 feet deep.

*Greenhorn district.*—Two deep mine operators and 1 placer reported the yield of $39 in gold, 7 ounces of silver, and 4,459 pounds of copper. There were 24 tons of ore mined and a small quantity of placer bullion taken from the gravels of Greenhorn Gulch, 2 miles west of Austin.

*Helena district.*—Small production was reported by the operators of 6 deep mines and 13 placers. The largest part of the ore treated, or 87 tons, contained lead and silver and was shipped directly to the

smelter. At an amalgamation and concentration mill 11 tons were treated. The total output, including the bullion from the placers, amounted to $5,339 in gold, 250 ounces of silver, and 4,080 pounds of lead, valued in all at $5,654. In 1910 the district yield amounted to $9,891 in gold and 385 ounces of silver.

*Lincoln district.*—The district output from 7 placers and 1 deep mine contained $1,097 in gold and 7 ounces of silver, valued in all at $1,101.

*Ottawa district.*—Ore and old tailings aggregating 31,365 tons, the larger part of which was treated at amalgamation and cyanidation milling plants, yielded $142,061 in gold and 41,295 ounces of silver, having a total value of $163,947, or an average recovery of $5.23 per ton. The placer yield made by 3 operators amounted to $263 in gold and 2 ounces of silver. The Cruse mine, developed to a depth of 900 feet, yielded the largest quantity of gold and silver ore, which was treated in the 20-stamp mill on the property. An important tonnage of ore was also mined from the St. Louis and Drumlummon mines. The ores produced were treated in a mill of 60 stamps, 20 of which were operated, equipped with vanners in 1911. Development has been carried on to a depth of 1,600 feet, and the mine is opened by a tunnel 1,300 feet long and an adit 3,500 feet in length. Old tailings, which had lodged in Canyon Creek, were treated by cyanidation by several operators.

*Poorman and Stemple districts.*—The operators of 2 deep mines and 4 placers reported a production yielding $1,910 in gold and 18 ounces of silver, having a total value of $1,920. The Twentieth Century and Klondike properties were operated, and the Nelson, Monkey, and one other placer were productive.

*Springhill and Unionville districts.*—The district output produced from 3 deep mines and 1 placer contained $3,338 in gold, 229 ounces of silver, 1,677 pounds of copper, and 2,524 pounds of lead. The total output was valued at $3,784, against an output valued at $5,417 in 1910. Some work was carried on at the Whitlatch property by lessees. The mine is opened by a vertical shaft 500 feet deep. The ore is largely sulphide with a siliceous gangue and contains iron and manganese. It is reported that the oxidized ores extend to a vertical depth of 400 feet.

*Vaughn district.*—Eight deep mines yielded 490 tons of ore which was shipped directly to smelters and contained $4,882 in gold, 7,166 ounces of silver, 1,213 pounds of copper, and 78,637 pounds of lead, valued in all at $12,370, or an average of $25.24 per ton. The placer yield amounted to $568 in gold and 14 ounces of silver. The Valley Forge property was the largest producer of lead-silver ore, containing values in gold and a little copper. Other producers were the Ida May, Josephine, Johnnie, and Enterprise properties.

### LINCOLN COUNTY.

Four properties yielded 4,642 tons of ore, which is 4,352 tons greater than was mined by 5 producers in 1910. The total average value per ton decreased from $10.98 in 1910 to $10.75 in 1911, and the gold and silver value from $6.90 to $2.84. The output of the county, including the gold and silver production of 3 placers, was $8,997 in gold, 15,032 ounces of silver, and 816,211 pounds of lead,

having a total value of $53,693. The greater part of the mine output was concentrated, yielding an important quantity of lead concentrates. There was also a small tonnage of ore treated at amalgamation mills yielding gold and silver bullion. The crude ore shipped to smelters containing lead aggregated only 22 tons. Preparations were made for a greater placer production in 1912, but in 1911 the output amounted to only $3,788 in gold and 17 ounces of silver, against a production valued at $1,863 in 1910.

*Libby district.*—The district output of ore and placer bullion contained $8,965 in gold, 14,621 ounces of silver, and 792,485 pounds of lead, valued in all at $52,375. The ore mined averaged in value $10.51 per ton for the gold, silver, and lead. The larger part of the ore was concentrated and the concentrates were shipped to the smelter. The Black Tail property was operated and its 10-stamp amalgamation mill ran a short time on gold and silver ore. The Snowshoe mine was operated under the receivership of the court during the latter part of the year. A tunnel 200 feet long connects with the shaft which is 500 feet in depth. The 250-ton concentration mill is equipped with jigs and Wilfley tables. The Comet and Gold Hill placers were operated, the former during the construction of flumes and the installation of the new equipment. A new company has been working the Hazel T. and Shaughnessy group of claims. A 10-ton concentrator has been built.

*Unorganized district.*—The Cabin Queen and the Banner & Bangle properties were credited with shipments of ore, which was taken out in the course of development work some years ago.

## MADISON COUNTY.

*Mine production of gold, silver, copper, and lead in Madison County, Mont., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| PLACERS. | | | | | | |
| Gold.....fine ounces.. | 22,553.49 | $466,322 | 28,296.86 | $584,948 | +5,743.37 | +$118,726 |
| Silver.....do.... | 2,468 | 1,333 | 4,516 | 2,393 | + 2,048 | + 1,060 |
| DEEP MINES. | | | | | | |
| Gold.....fine ounces.. | 16,674.82 | 344,699 | 13,324.46 | 275,441 | −3,350.36 | − 69,258 |
| Silver.....do.... | 113,277 | 61,169 | 97,841 | 51,856 | − 15,436 | − 9,313 |
| Copper.....pounds.. | 39,159 | 4,973 | 25,533 | 3,192 | − 13,626 | − 1,781 |
| Lead.....do.... | 243,543 | 10,716 | 225,416 | 10,144 | − 18,127 | − 572 |
| Total..... | ..... | 889,112 | ..... | 927,974 | ..... | + 38,862 |

From 111 deep-mine producers there was an output of 28,765 tons of ore in 1911. This is 2,956 tons less than was reported by 82 producers in 1910. The total average value per ton decreased from $13.29 in 1910 to $11.84 in 1911, and the gold and silver value in this ore from $12.79 to $11.38. Nearly all of the ore mined, or 25,911 tons, was treated at milling plants, yielding bullion by amalgamation, which contained 2,407.19 ounces of gold and 848 ounces of silver, and by cyanidation 1,411.30 ounces of gold and 36,856 ounces

of silver, valued in all at $98,918, or an average recovery of $3.82 per ton. There were also produced at milling plants 1,318 tons of concentrates containing $80,944 in gold, 30,502 ounces of silver, 11,295 pounds of copper, and 2,058 pounds of lead, valued in all at $98,615, or an average value of $74.82 per ton. The crude ore shipped to smelters aggregated 2,826 tons, which contained $115,023 in gold, 29,593 ounces of silver, 14,181 pounds of copper, and 223,358 pounds of lead, having a total value of $142,531, or an average of $50.44 per ton. The output of 16 operators of placers by hydraulicking and sluicing, and of 1 producer operating 4 dredges, yielded bullion containing $584,948 in gold and 4,516 ounces of silver. The total yield from placers in 1910 was $466,222 in gold and 2,468 ounces of silver, and in 1909 the output was $427,927 in gold and 3,328 ounces of silver.

*Alder Gulch district.*—Fourteen deep-mine producers shipped 412 tons of ore directly to the smelters and 62 tons were treated at amalgamation mills. The output contained $26,099 in gold, 7,478 ounces of silver, and 1,786 pounds of copper, having a total value of $30,286, or an average of $63.90 per ton. The ore output in 1910 was valued at $15,587 and averaged $41.12 per ton. Among the principal producers were the U. S. Grant, High Tariff, Prospect, and Hidden Treasure, and St. Lawrence properties. There were 8 reports received from placer operators, whose combined production amounted to $582,055 in gold and 4,492 ounces of silver, having a total value of $584,435. Four dredges operating on 1 property and 7 placer properties worked by hydraulicking and sluicing produced the greatest part of the district output. The average fineness of the placer gold in the district was about 0.857.

The operations of the Conrey Placer [1] Mining Co. and those of the Poor Farm Placer Co., both under one management, are at Ruby, Madison County, Mont., about 80 miles southeast of Butte.

The principal work is in Alder Gulch, the mouth of which has an elevation of 5,200 feet above the sea. The locality is only 50 to 60 miles from the Yellowstone National Park and is reached by rail by the Northern Pacific branch line from Whitehall to Alder. * * * Altogether the two companies have had seven dredges at work on their ground—three steam sluice dredges, one electrical sluice dredge, three stacker table dredges of the type used in California. The three steam dredges have been dismantled and discarded, and the companies now have a fleet of four boats at work. The No. 3 * * * is the largest and most perfect of this class in the world. It was designed in 1904 and started work in 1906. * * * No. 4 started work in June. It has a rated capacity per month of 300,000 cubic yards, but this depends on the nature of the gravel. The highest yardage up to the present is 260,000. The dredge is said to be as large as any other dredge now at work in the world. The hull is 150 feet long by 58 feet wide by 13 feet deep; the bow, stern, and well are all sheathed with light steel plates for winter work in ice, which also requires an exceptional depth of hull. * * * The sluices coming from the upper sections on each side of the 9-foot washing screen are made longer for the upper sections and gradually reduced toward the end. * * * In many respects conditions of dredging at Ruby, Mont., are similar to those existing in California. The bedrock is a volcanic ash similar to that at Oroville, but possibly of a more clayey and tenacious nature. The gravel is compact and tenacious, but not cemented or hard as the hardest in the Oroville district. It, however, has occasional bowlders larger than those found in California. The chief disadvantage of the Montana workings over those of California is the severity of the winter climate, where the thermometer is known to fall as low as 30° to 40° F. below zero. * * * The average wages of Montana are also in advance of those in California, and the working costs at Ruby have been somewhat in excess of those in California.

[1] Jennings, Hennen, Gold-dredging at Ruby, Mont.: Min. and Sci. Press, Jan. 6, 1912, p. 84.

During the winter season dredges have twice sunk and been badly damaged, and costs have thus been made exceptionally high. The system of keeping accounts also takes into consideration bucket-ladder renewals. In spite of all these factors the average cost for the last two years has not been much over 7 cents and some months has run below 6 cents per yard. It is hoped to still further reduce these figures when No. 4 has had, with the other dredges, a completed full year's run.

The Conrey and Poor Farm companies, between them, have 2,500 acres of ground, all of which, however, is by no means dredgable. In addition to the fleet of dredges the companies have a very extensive machine-shop equipment, and they do all their repairs at their own shops and, in fact, the assembling and machining of much of their bucket lines. They also have a complete transformer station for reducing the line tension from 80,000 to 2,200 volts. The companies issue no printed annual report, as there are but few shareholders, and these in no way speculate in the stock.

*Lower Hot Springs district.*—The producers of ore from 15 properties shipped 148 tons, containing $4,291 in gold, 3,768 ounces of silver, 737 pounds of copper, and 641 pounds of lead, having a total value of $6,409, or an average of $43.30 per ton. Eight deep mines in 1910 yielded 183 tons of ore, valued at $3,705, or an average value of $20.24 per ton. The Madison group, Red Bluff, and Birdie properties were the principal shippers.

*Mineral Hill district.*—Nearly the entire output of the district was treated at amalgamation and concentration mills and aggregated 15,119 tons, producing bullion containing $23,067 in gold and 473 ounces of silver, valued in all at $23,318, or an average recovery value of $1.54 per ton, and also yielded 967 tons of concentrates, which contained $46,280 in gold, 3,836 ounces of silver, 6,842 pounds of copper, and 1,418 pounds of lead, valued in all at $49,232, or an average value of $50.91 per ton. Crude ore amounting to 267 tons was shipped directly to smelters and contained $14,581 in gold, 1,297 ounces of silver, 1,703 pounds of copper, and 6,603 pounds of lead, having a total value of $15,778, or an average of $59.09 per ton. In 1910 the total value of 15,301 tons of ore, produced by 10 operators, aggregated $142,098. The Boss Tweed and Clipper were the principal producers of ore, the larger part being treated at the 15-stamp amalgamation and concentration mill at the property. The mine is opened by an adit 1,000 feet long, which cuts the ore body at a depth of 700 feet below the surface. The ore produced from the Boss Tweed is sulphide iron ore and that mined from the Clipper is largely oxidized. Gold bullion, concentrates, and crude shipping ore, both of the latter containing gold, silver, and some copper, were produced. The Strawberry mine, which is opened by the main adit tunnel 800 feet long and a crosscut 600 feet long, produced sulphide ore with a siliceous gangue, carrying a small percentage of copper in addition to the gold and silver. All of the ore was milled in the 10-stamp concentration and amalgamation plant on the property. The Galena group, which is opened by an adit 1,300 feet long, produced ore similar to that of the other properties, which was treated in the 20-stamp amalgamation and concentration mill on the property. The Old Joe property was operated, yielding gold and silver ore with a little copper, which was milled, and the bullion and concentrates were shipped.

*Norwegian district.*—All of the ore mined, or 140 tons, was shipped directly to the smelter and, with the content of 28 tons of old tailings, yielded $4,416 in gold, 635 ounces of silver, 1,694 pounds of copper, and 199 pounds of lead, valued in all at $4,974, or an average of $29.61 per ton. The Gold Hill, Black and Hidden Treasure, and Bachelor were the principal producers.

*Rabbit district.*—Six deep mines yielded 98 tons of ore of shipping grade, containing $1,887 in gold, 732 ounces of silver, 161 pounds of copper, and 21,612 pounds of lead, valued in all at $3,268, or an average of $33.35 per ton. The Hazzard, Gold Coin, Emma, Clifton, and Abbie claims were the producers of ore in 1911.

*Ramshorn district.*—Seven placers and 1 deep mine yielded $3,242 in gold and 265 ounces of silver. The placers in California, Harris, and Bivens gulches were the most productive by hydraulicking and sluicing methods. A portion of the placer gold produced was sold to jewelers and had an average fineness of about 842.

*Sheridan district.*—The production of 1,055 tons of ore by 9 deep mines was largely treated at amalgamation mills, yielding bullion and concentrates, and 130 tons were shipped directly to smelters. The ore mined contained $14,788 in gold, 4,078 ounces of silver, 4,077 pounds of copper, and 19,785 pounds of lead, in all valued at $18,349, or an average of $17.39 per ton. The Gladstone property yielded chiefly sulphides, which were treated in the 10-stamp mill and concentrator on the property. The Noble, Tamarack, Jay, and Bell properties also produced ore.

*Silver Star district.*—Ten operators of deep mines produced 954 tons of ore treated in gold and silver mills, containing $4,759 in gold and 175 ounces of silver, which was recovered by cyanidation, and 568 tons of ore shipped directly to smelters containing $23,169 in gold, 1,527 ounces of silver, 4,096 pounds of copper, and 25,174 pounds of lead. The total output of the district was valued at $30,475, and the milling and shipping ore averaged $20.02 per ton. Most of the ore was oxidized and was produced from the Iron Rod mine. Part of the ore was treated in a 15-stamp Hudson mill equipped for cyanidation. Shipments of ore were made from the Broadway, Aurora, Crickett and Grasshopper, King Fisher, and Twilight properties.

*Summit district.*—From the operations of 11 deep mines, 8,873 tons of ore were milled or shipped. Most of the ore, 8,428 tons, was treated in amalgamation and cyanidation mills, and yielded $41,902 in gold and 36,847 ounces of silver, having a total value of $61,431, or an average of $7.29 per ton. There were also 248 tons of ore concentrated, containing $30,365 in gold, 25,292 ounces of silver, and 1,938 pounds of copper, having a total value of $44,012, and an average of $177.46 per ton. There were also shipped 445 tons of ore directly to the smelter, which contained 609.97 ounces of gold, 3,598 ounces of silver, and 291 pounds of copper. An important production of bullion was made from ores of the Apex mine, which is opened by a vertical shaft 300 feet deep and has 350 feet of drifts. The stamp mill on the property was operated during the greater part of 1911. The principal production of the district was from the Easton Pacific property, from which were shipped concentrates containing gold, silver, and copper; and an important lot of silver bullion was recovered by cyanidation. Most of the ore produced in the Winnetka property was sulphides and tellurides, with a siliceous gangue, and was shipped directly to the smelters. The oxidized ores are reported to go to a depth of 150 feet. The upper levels of the mine were extended on the vein 450 feet. An adit was started at the bottom of the hill to cut the vein 200 feet below the upper workings.

*Tidal Wave district.*—Reports were received from 22 producers of deep mines and 1 placer, yielding 400 tons of ore. The total output

contained $12,335 in gold, 6,415 ounces of silver, 2,205 pounds of copper, and 146,802 pounds of lead, valued in all at $22,616, or an average of $56.32 per ton. An important tonnage of lead ore of shipping grade, carrying good values in gold, was mined from the Ella group, which is opened by a tunnel 200 feet long. Production was also made from the Goldie, Miners Union, Blue Jay, Carolina, Georgia Gulch, Kineo, Lottie, Nightingale, Speculation, Oregon, and Wild Rose properties.

*Upper Hot Springs district.*—The output of 5 properties aggregated 324 tons, the larger part of which was treated at a cyanide plant. The total district output contained $5,905 in gold, 312 ounces of silver, 693 pounds of lead, and a small quantity of copper, valued in all at $6,102, or an average of $18.83 per ton. The largest producer was the Monitor and Revenue property, operated under lease, which produced an oxidized ore treated by the cyanide process. The Red Rose, Boaz, and Balmoral properties were productive of lead ore with considerable values in gold and a small quantity of silver.

*Washington Gulch district.*—Two deep mines produced 247 tons of ore, which contained $6,949 in gold, 938 ounces of silver, and 2,489 pounds of lead, valued in all at $7,558, or an average of $30.60 per ton.

## MEAGHER COUNTY.

Most of the ore mined in 1911, or 63 tons, was shipped directly to the smelters and contained $2 in gold, 91 ounces of silver, 10,862 pounds of copper, and 12,544 pounds of lead, having a total value of $1,972, or an average of $31.30 per ton. There were 4 tons of ore treated by the amalgamation process, yielding $88 in gold and silver. The total output of the county was mined by 3 operators, producing 16 tons more than was mined by 2 operators in 1910. The total value of the ore per ton produced decreased from $33.90 in 1910 to $30.75 in 1911 and the gold and silver value in the ore from $2.19 to $2.06 per ton. Only one placer operator reported production in 1911.

*Musselshell district.*—The Musselshell and Neumansville, Crown Point, and Badger mines produced ore, part of which was shipped and the rest treated by the amalgamation process. The Josephine placer on Elk Creek was operated. Some lead-copper ore was shipped from the Cleveland mine.

## MISSOULA COUNTY.

*Mine production of gold, silver, and lead in Missoula County, Mont., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| PLACERS. | | | | | | |
| Gold.....fine ounces.. | 1,749.34 | $36,162 | 986.61 | $20,395 | −762.73 | −$15,767 |
| Silver.....do.... | 78 | 42 | 52 | 27 | − 26 | − 15 |
| DEEP MINES. | | | | | | |
| Gold.....fine ounces.. | 137.82 | 2,849 | 701.44 | 14,500 | +563.62 | + 11,651 |
| Silver.....do.... | 8,003 | 4,322 | 2,536 | 1,345 | − 5,467 | − 2,977 |
| Lead.....pounds.. | 92,523 | 4,071 | 28,979 | 1,304 | −63,544 | − 2.767 |
| Total..... | ..... | 47,446 | ..... | 37,571 | ..... | − 9,875 |

The operators of 3 properties reported the mining of 4,527 tons of ore, which is 2,809 tons more than was produced by the same number of operators in 1910. The total average value per ton decreased from $6.54 in 1910 to $3.79 in 1911, and the gold and silver value in this ore from $4.17 to $3.50 per ton. Nearly all of the ore mined, or 4,470 tons, was treated at milling plants, and the bullion recovered by the amalgamation process contained 701.44 ounces of gold and 46 ounces of silver, having a total value of $14,525, or an average recovery of $3.25 per ton. There were 57 tons of ore shipped directly to the smelter, which contained 2,490 ounces of silver and 28,979 pounds of lead, having a total value of $2,624, or an average of $46.04 per ton. The placer output reported by 27 operators carrying on hydraulicking and sluicing operations, and 2 companies operating dredges, aggregated $20,395 in gold and 52 ounces of silver, having a total value of $20,422. In 1910 the placer output was valued at $36,204 and in 1909 it was valued at $25,308.

*Cedar, Quartz, and Trout Creek districts.*—Twenty-two placer mines yielded $16,632 in gold and 48 ounces of silver. Nineteen placer operators and 1 deep mine yielded $34,493 in gold and 92 ounces of silver in 1910. The principal placer production in 1911 came from the Cedar Creek placers, which were worked by the Kansas City dredge. Hydraulic mining was carried on at the Deep Gulch placer. The Blue Bird, California, and Windfall properties were also producers.

*Iron Mountain district.*—A test lot of sulphide silver-lead ore was shipped from the Iron Mountain Tunnel property in 1911. Development of the mine was carried on throughout the year. The property is developed by a vertical shaft 2,000 feet deep and has 10,000 feet of drifts with an adit 6,115 feet long.

*Ninemile district.*[1]—The output of ore and gold bullion from placers aggregated $16,777 in value. The placer yield was reported by 7 operators, and 1 deep mine produced free gold milling ore. A dredge was erected on the Kennedy Creek placers and operated but a short time, when it was closed down indefinitely. Other placers producing were those on Pine Creek, Marion Creek, and McCornick Creek. The Nine Mile property was under lease during the year and produced some gold bullion, which was recovered from ore treated in a 20-stamp amalgamation mill.

*St. Regis district.*—The Gold Chrome property was operated two months during the year. Low-grade gold and silver ore was treated in the stamp mill, which is equipped with 10 stamps and a 22-foot tube mill.

### PARK COUNTY.

The output of 58 tons of ore was produced from 3 mines and is 95 tons less than was produced in 1910 from 2 properties. The total average value per ton decreased from $52.42 in 1910 to $35.31 in 1911, and the gold and silver value increased from $9.72 to $12.14 per ton. There were 13 tons of ore treated by the amalgamation process, and 45 tons containing lead were shipped crude to smelters.

*Emigrant Creek district.*—The production of 6 placers in 1911 amounted to $2,235 in gold and 21 ounces of silver.

[1] Schrader, F. C., Gold-bearing ground moraine in northwestern Montana: Bull. U. S. Geol. Survey No. 470, 1911, pp. 62-74.

*New World district.*—Oxidized lead ore was shipped from the Gallatin mine.

*Sheepeater district.*—From the ore treated from 2 properties, $534 in gold and 6 ounces of silver were recovered, valued in all at $537, or an average of $41.31 per ton.

## POWELL COUNTY.

*Mine production of gold, silver, copper, and lead in Powell County, Mont., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| PLACERS. | | | | | | |
| Gold.....fine ounces.. | 1,394.70 | $28,831 | 1,129.22 | $23,343 | − 265.48 | −$5,488 |
| Silver.....do.... | 164 | 88 | 163 | 86 | − 1 | − 2 |
| DEEP MINES. | | | | | | |
| Gold.....fine ounces.. | 671.83 | 13,888 | 1,778.84 | 36,772 | +1,107.01 | +22,884 |
| Silver.....do.... | 15,982 | 8,630 | 25,496 | 13,513 | + 9,514 | + 4,883 |
| Copper.....pounds.. | 79,767 | 10,130 | 41,468 | 5,183 | − 38,299 | − 4,947 |
| Lead.....do.... | 48,041 | 2,114 | 110,796 | 4,986 | + 62,755 | + 2,872 |
| Total..... | ..... | 63,681 | ..... | 83,883 | ..... | +20,202 |

The operators of 19 deep mines produced 2,536 tons of ore, which is 1,473 tons greater than was produced in 1910 by 14 mines. The total average value per ton decreased from $32.70 in 1910 to $23.84 in 1911, and the gold and silver value from $21.18 to $19.83 per ton. A little over half of the ore, containing 1,104.59 ounces of gold, 25,260 ounces of silver, 41,468 pounds of copper, and 110,191 pounds of lead, having a total value of $46,365, or an average of $34.12 per ton, was shipped directly to smelters. Milling ore, amounting to 1,177 tons, yielded 660.75 ounces of gold and 210 ounces of silver, having a total value of $13,770, or an average of $11.70 per ton. There were also produced from one of the mills 7 tons of concentrates, containing $279 in gold, 26 ounces of silver, and 605 pounds of lead. The total output of the county was divided into 2,177 tons of dry or siliceous ore, 68 tons of copper ore, and 291 tons of lead ore. Placers were operated by 27 producers by hydraulicking and sluicing methods, and the gravels of 1 property were worked by a small dredging equipment. The bullion produced from placers contained $23,343 in gold and 163 ounces of silver. In 1910 the total placer yield was $28,831 in gold and 164 ounces of silver.

*Big Blackfoot district.*—The output of 1 deep mine and 1 placer aggregated $917 in gold, 19 ounces of silver, and 605 pounds of lead, valued in all at $955.

*Coloma district.*—One deep mine and 1 placer yielded $2,308 in gold, 46 ounces of silver, and 244 pounds of copper, valued in all at $2,362. The Dandy group yielded copper and a considerable part of the gold.

*Ontario district.*—Two deep mines yielded 90 tons of ore, containing $1,095 in gold, 2,367 ounces of silver, 5,625 pounds of copper, and 4,392 pounds of lead, valued in all at $3,251, or an average of $36.12 per ton. Most of the ore was sulphide, containing copper, lead, and silver, and was shipped from the Lee Mantle property. The mine

is opened by 400 feet of drifts and was worked under a lease part of the year. The Democrat mine produced carbonate lead ore, containing considerable values in gold and silver. The property is opened by a vertical shaft 100 feet deep and has 80 feet of drifts.

*Ophir district.*—Ore was produced from 7 deep mines, aggregating 1,971 tons, which contained $26,779 in gold and 17,258 ounces of silver, valued in all at $43,257, or an average of $21.95 per ton. A large part of the production was treated at amalgamation mills and yielded gold and silver bullion, and 936 tons, containing lead and copper besides the gold and silver, were shipped directly to smelters. The largest producer was the Julia property, which is opened by a vertical shaft 200 feet deep and has 300 feet of drifts. Thirteen placers yielded $2,475 in gold and 8 ounces of silver. Much of the work was done by hydraulicking and sluicing.

*Pioneer district.*—Seven placer producers yielded $18,038 in gold and 143 ounces of silver. One deep mine yielded gold and silver ore averaging $36.40 per ton. The placer operations were carried on by hydraulicking and sluicing. The largest production was made from the Pioneer Gulch placers, situated on Gold Creek, about 1 mile from Pioneer. Important productions were also made on the headwaters of Gold Creek.

*Washington Gulch district.*—Three deep mines and 4 placers yielded $2,591 in gold and 29 ounces of silver. Forty-one tons of ore were mined, which yielded gold and silver bullion, treated by the amalgamation process, and a small quantity of gold and silver concentrate. About 3 miles from Finn, on Washington Creek, placers were operated a short time with a small walking dredge, which was completed during the year. The Hansmeier 5-stamp mill, using the amalgamation process, was operated for a few days while testing machinery. The Mutual property was operated during October and November and made a small production of ore.

*Zozell district.*—The production of ore from 4 deep mines aggregated 284 tons, the larger part of which, 249 tons, was shipped directly to the smelter, and the remainder produced gold and silver bullion. The output of the district contained $5,192 in gold, 5,759 ounces of silver, and 41,752 pounds of lead, valued in all at $10,123, or an average of $35.64 per ton. Lead ore carrying considerable values in gold and silver was mined from the Emery property. The Blue Eyed Maggie and Bonanza mines were also producers of ore.

### RAVALLI COUNTY.

The ore production in 1911 was made by 1 operator who mined 225 tons of ore. This is 169 tons greater than was produced from 2 properties in 1910. The total average value per ton decreased from $85.91 in 1910 to $14.83 in 1911, and the gold and silver value in this ore from $41.77 to $6.03 per ton. The ore produced contained gold, silver, copper, and lead, which was treated in a concentration mill and the concentrate was shipped to the smelter. The output of 7 placers operated by hydraulicking and sluicing methods yielded bullion containing $2,836 in gold and 10 ounces of silver.

*Hughes Creek district.*—The largest amount of placer mining was carried on at Hughes Creek on the south fork of Bitter Root River, within 10 miles of Alta post office, by hydraulicking of stream gravels.

SANDERS COUNTY.

Ore amounting to 136 tons was produced from 3 deep mines. This is 330 tons less than was produced from 4 mines in 1910. The total average value per ton increased from $25.40 in 1910 to $26.15 in 1911, and the gold and silver value in this ore decreased from $8.56 to $5.07 per ton. All of the ore was shipped crude to smelters and contained 11.08 ounces of gold, 870 ounces of silver, 14,958 pounds of copper, and 22,150 pounds of lead, having a total value of $3,557, or an average of $26.15 per ton. No placer operations were reported.

*Spring Gulch district.*—The largest amount of sulphide lead ore, containing silver, copper, and a little gold, was mined from the King and Queen group. This property is opened by a vertical shaft 509 feet deep and 700 feet of drifts and has an adit 400 feet long. The loading station for the ore is Ashmore siding on the Chicago, Milwaukee & Puget Sound Railway. The Dixon and St. Regis properties were also producers of copper sulphide ore.

SILVER BOW COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Silver Bow County, Mont., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 37,014.37 | $765,165 | 35,405.90 | $731,905 | − 1,608.47 | − $33,260 |
| Silver.....do.... | 10,400,840 | 5,616,454 | 10,258,122 | 5,436,805 | − 142,718 | − 179,649 |
| Copper.....pounds.. | 284,264,862 | 36,101,637 | 272,271,171 | 34,033,896 | −11,993,691 | −2,067,741 |
| Lead.....do.... | 350,173 | 15,408 | 1,017,273 | 45,777 | + 667,100 | + 30,369 |
| Zinc.....do.... | 31,620,184 | 1,707,490 | 43,734,150 | 2,492,846 | +12,113,966 | + 785,356 |
| Total..... | ..... | 44,206,144 | ..... | 42,741,229 | ..... | −1,464,915 |

Owing partly to the consolidation of several properties, the number of operators decreased from 83 in 1910 to 63 in 1911. The ore produced aggregated 4,569,942 tons. This is 139,487 tons less than was produced in 1910. The total average value per ton decreased from $9.38 in 1910 to $9.35 in 1911, but the gold and silver value of $1.35 per ton in 1910 remained the same in 1911. The larger part of the ore mined, or 3,991,699 tons, was concentrated at Butte, Great Falls, Anaconda, and Basin. The quantity of ore treated at concentration mills decreased from 4,138,698 tons in 1910 to 3,991,699 tons in 1911, and the yield of concentrates increased from 1,277,588 tons in 1910 to 1,316,731 tons in 1911. Different kinds of ore of shipping grade were shipped directly to smelters, the dry or siliceous ores smelted amounting to 5,760 tons, containing 2,232.43 ounces of gold, 193,608 ounces of silver, 12,439 pounds of copper, and 3,958 pounds of lead. First-class copper sulphide ores, aggregating 564,538 tons, contained 8,109.76 ounces of gold, 2,504,364 ounces of silver, and 72,597,538 pounds of copper. Lead sulphide ores of shipping grade amounted to 481 tons and contained 94.07 ounces of gold, 7,862 ounces of silver, 6,750 pounds of copper, and 166,635 pounds of lead. Concentrates of two different kinds were smelted. Those classified as copper sulphide

concentrates aggregated 1,255,566 tons and were recovered from 3,766,113 tons of ore and contained 22,950.69 ounces of gold, 7,060,180 ounces of silver, and 193,044,943 pounds of copper. Zinc sulphide concentrates recovered from 225,586 tons of ore aggregated 61,165 tons and yielded 817.14 ounces of gold, 491,161 ounces of silver, 1,340,427 pounds of copper, 846,680 pounds of lead, and 43,734,150 pounds of zinc. The total dry or siliceous ores mined in 1911 aggregated 12,902 tons, of which the ore containing gold and silver as its greatest value aggregated 7,831 tons, containing 1,693.82 ounces of gold, 14,164 ounces of silver, 927 pounds of copper, and 2,079 pounds of lead. Of this ore, mines in the Divide Creek district produced 6,328 tons; Highland district, 943 tons; and Summit Valley district, 560 tons. Dry or siliceous ores containing chiefly silver values aggregated 5,071 tons and contained 1,439.69 ounces of gold, 179,627 ounces of silver, 11,512 pounds of copper, and 1,879 pounds of lead. Included with the smelting ores was the copper in the form of precipitates recovered from mine waters, aggregating 5,075,288 pounds; and 193,786 pounds were also recovered from old smelter cleanings. The placer production of the county aggregated $6,175 in gold and 74 ounces of silver, against an output in 1910 of $2,498 in gold and 18 ounces of silver.

*Divide Creek district.*—The greater part of 6,368 tons of ore mined in the district was from 8 properties and was treated by the cyanidation process. The total content of the ore of the district was $12,508 in gold, 911 ounces of silver, 12,341 pounds of copper, 2,079 pounds of lead, valued in all at $14,626, or an average of $2.30 per ton. The placer yield amounted to $48 in gold. The principal part of the ore tonnage came from the Gold Hill property, which was operated the latter half of 1911. The mill has a capacity of 60 tons of ore per day, and is equipped with 2 Huntington mills and 2 Holderman filters. Ore was shipped from the Columbia, Backbone and Arctic, Bonanza, and Blue Jacket properties.

*German Gulch district.*—Placer operators produced small amounts of gold, which was accounted for by purchasers of the gold or directly by the producers. The total output aggregated $4,579 in gold and 66 ounces of silver.

*Highland district.*—The district output was made by 4 deep mines and 4 placers, and was valued at $11,158. The larger part of the ore mined, or 900 tons, was treated at amalgamation mills, producing gold and silver bullion, and 43 tons of ore were shipped directly to the smelters. The placer yield amounted to $1,531 in gold and 8 ounces of silver. The Murphy mine was the principal producer of siliceous gold ore, which was treated in the 5-stamp mill, equipped for amalgamation, on the property. The mine is opened by a vertical shaft 300 feet deep, and has an adit 600 feet long. Other mines producing were the Bernard, Golden Surprise, and Bull of the Woods.

*Summit Valley district.*—In 1911 there were 51 producers reporting against 76 in 1910 and 58 in 1909. Practically all of the output of Silver Bow County comes from the mining region immediately surrounding Butte. The mines were operated in 1911 under somewhat curtailed conditions, advantage being taken of the lull in the operations of the companies to make extraordinary repairs in the different working shafts. The introduction of electricity and compressed air

are the means by which it is estimated the cost of producing copper will be lessened, and the hoisting of a greater tonnage will be effected when conditions warrant. Three Nordberg air compressors, each with a capacity of 7,500 feet of air per minute, have been put in at the Anaconda mines. Electric power will be brought from Great Falls, a distance of 130 miles, and it will require 3,600 horsepower to operate the air compressors at full capacity.

Owing to the unsatisfactory condition of the copper metal market at the beginning of the year, it was deemed good business policy to curtail the output of copper from the mines of the Anaconda Copper Mining Co.,[1] at least until such a time as conditions had improved, and although both the tonnage of ore extracted and the output of refined copper were reduced materially, development work was maintained at a normal rate, and advantage was taken of the slackness of operations to retimber certain shafts and make extraordinary repairs, which could not be done when the mines were in full operation.

The mines produced during the year 3,844,070.20 tons of ore and 4,602.61 tons of precipitates, or a total of 3,848,672.81 tons. The reduction works treated for all companies during the year 3,154,035.94 dry tons of ore and other cupriferous material at Anaconda, and 1,101,777.84 dry tons of ore and other cupriferous material at Great Falls. Of this amount 3,756,235.05 tons of ore furnished from the company's mines, 499,077.33 tons of purchased ore, and 501.40 tons of precipitates from the old works were treated, from which there was produced 191,573,780 pounds of fine copper, 8,510,122.14 ounces of silver, and 40,546.216 ounces of gold at Anaconda, and 67,833,313 pounds of fine copper, 1,221,439.210 ounces of silver, and 8,403.570 ounces of gold at Great Falls—a total production of 259,407,093 pounds of fine copper, 9,731,561.35 ounces of silver, and 48,949.768 ounces of gold. * * * The Anaconda shaft was out of commission for the entire year, but was thoroughly repaired to the 2,400-foot level, with the exception of 100 feet near the surface. * * * The St. Lawrence shaft was thoroughly repaired from the surface to the bottom, and mining operations were resumed on May 11. The shaft was sunk to the 2,200-foot level. * * * The Mountain Consolidated shaft is 2,300 feet deep, and sinking is now in progress, it being the intention to establish levels at depths of 2,400 and 2,500 feet. * * * Sinking operations were carried on steadily in the Belmont shaft during the year 1911, the shaft having been sunk 218 feet to a depth of 2,089 feet, 67 feet below the Anaconda 2,400-foot level. * * * Work was done and ore hoisted on all of the levels of the Diamond mine from the 900-foot to the 2,800-foot level. * * * The Gagnon No. 1 shaft was put out of commission so far as the hoisting of ore was concerned, as connections were made from the Original shaft with the lower levels of the Gagnon mine. * * * The ore from three mines formerly hoisted through independent shafts was brought to surface through the Steward shaft during the year 1911. The Little Mina vein was worked on the 1,000-foot and 1,200-foot levels; the Clear Grit vein at all points between the 500-foot and the 1,100-foot levels, while the Steward mine was stoped and developed from the 1,700-foot to the 2,300-foot levels. * * * The Poulin shaft was connected with the 1,600-foot drain tunnel of the High Ore mine. The ore from the Poulin mine has always carried small values in copper, but the silver content, much higher than that contained in the average ores of the district, makes it of commercial grade. * * * During the eight months in which the Mountain View mine was operated development work was done in five separate veins at a normal rate, with good results. * * * The Badger State shaft was not sunk during the year, but extensive development work was carried on, and has developed the veins to a depth of 1,800 feet. * * * The Rarus shaft was out of commission the greater part of the year, and was retimbered from the 1,000-foot level to surface, and in consequence there was but little development work done. The Tramway shaft is now 2,100 feet deep, but the lowest working level is at a depth of 2,000 feet. * * * The Berkeley shaft was sunk 156 feet during the year and is now 1,000 feet in depth. * * * The Pennsylvania shaft, now 1,800 feet in depth, was not sunk during the year, but development work was carried on to a normal extent on all of the levels. * * * While development work was carried on as usual

[1] Annual report for year ending Dec. 31, 1911.

throughout the Leonard mine, special attention was paid to the 1,600-foot and 1,800-foot levels, and the results of development would indicate the existence on the 1,600-foot level of a zone of ore approximately 400 feet wide and 500 feet long, of which body the engineers estimate 50 per cent will prove to be ore of commercial grade. * * * The development during the year, in the form of drifts, crosscuts, upraises, winzes, and shafts, totaled 30.7 miles of work, and the amount of ore developed was much in excess of the tonnage extracted. The shafts of the different properties were sunk during the year to additional depths, aggregating 3,711 feet. * * * Tests were carried on during the year with a large centrifugal concentrating unit, which demonstrated its ability to concentrate successfully; but on account of imperfections in the machine it was found impossible to operate it continuously. In order to arrive at absolute results, a new unit will be completed early in the year 1912, which will enable the engineers in charge to determine as to its practicability.

During the year the Speculator [1] shaft was sunk to the 2,800-foot level, and all the preparatory work has now been completed on both the 2,600-foot and 2,800-foot levels.

* * * The Granite Mountain shaft was completed to a depth of 1,048 feet. This work is still being pushed and should reach the 2,000-foot level by October, 1912. * * * During 1911 the lateral development work was very largely confined to the Crœsus and Snowball veins, and the latter vein is to-day largely within the limits of the Berlin claim, and has resulted in opening up valuable ore bodies in each of them. A very noticeable fact in connection with these northern veins is the comparatively high silver values contained in the ores there developed. The opening up of the Adirondack vein on the 2,000-foot level and the discovery there of a body of ore 6 feet in width carrying 7.3 per cent copper and 7.6 ounces silver occurred in December. The 1,800-foot level directly above this showed about 4 feet of the same grade of ore. * * * During 1911 420,203 wet tons of ore were shipped, and there were treated at the smelter 410,694 dry tons of ore, of which 27,114 dry tons, or 6.6 per cent, were first-class, and 383,580 dry tons, or 93.4 per cent, were second-class. This ore produced 24,816,669 pounds of fine copper, 1,134,300 ounces of silver, and 1,280.95 ounces of gold. * * * Dividends paid during 1911 aggregated $1,827,060. The mine was in operation 342½ days, the average number of men employed was 835.1, and the average number of tons hoisted per day was 1,220.74. There was in sight on January 1, 1912, in the various stopes and levels, the following ore:

| | Tons. |
|---|---|
| Speculator vein | 4,100 |
| Adirondack vein | 4,400 |
| Edith May vein | 337,150 |
| Jessie vein | 145,580 |
| Croesus veins | 20,310 |
| South Gem vein | 39,530 |
| Snowball vein | 159,850 |
| Total | 710,920 |

of an average assay value of 4.50 per cent copper and of 4.25 ounces silver per ton. The increase in silver values is due to the large amount of ore developed during the year in the Snowball vein. The principal feature of the development work during the year was the development of the Snowball vein, and this work will be continued during the present year on the 2,000-foot, 2,200-foot, and 2,400-foot levels, as well as the development of the Berlin claim.

The production of the Tuolumne mine [2] during the year 1911 was 30,499 tons of ore, containing 4,261,705 pounds of copper, 96,373 ounces of silver, and 145.52 ounces of gold.

The average contents per ton of the ore for the year was 7.157 per cent of copper and 3.237 ounces of silver. The gross value of these metals was $472,942.30 and the net value after deducting the smelter and freight charges was $261,448.38. * * * The main operating shaft of the company has been sunk to the 1,800-foot level, and the workings from this level recently encountered one of the best ore bodies yet found in the mine. * * * Dividends were paid in 1911 amounting to $215,525.

[1] Annual report North Butte Mining Co. for the year ending Dec. 31, 1911.
[2] Annual report for the year ending Dec. 31, 1911.

The East Butte Copper Co.[1] operating the Pittsmont property mined 95,910 tons of ore, averaging 5.62 per cent of copper. The largest part, or 68 per cent of the total, averaging 6.9 per cent of copper, was smelted, and the remainder, averaging 2.86 per cent of copper, was concentrated. The shaft of the Pittsmont is 1,200 feet deep, but the mine has been opened 100 feet deeper by winze. No work is being done on the old East Butte property. A notable improvement was made at the Pittsmont smelter when the Dwight-Lloyd sintering plant was put in operation for conglomerating flue dust and putting it into convenient form for the blast furnace. The Pittsmont smelter produces about 50 tons of dust daily and before the sintering plant was put in the dust was shipped to the Washoe smelter at Anaconda.

The Butte-Alex Scott mine is developed to a depth of 1,800 feet. Irregular shipments of a copper-silver ore were made during 1911. Work at the Davis-Daly mine was mainly pursued on the 1,400-foot and 1,700-foot levels of the Colorado shaft, which is situated in the heart of the city of Butte. Shipments of ore have been made since the middle part of the year. Lessees were at work in the upper levels of the Raven property and mined several lots of ore. The shaft is opened to a depth of 1,500 feet and is in water to the 1,175-foot level. The Ophir mine is opened to a depth of 1,000 feet. Shipments of ore were made during 1911 to Anaconda. A concentrator for the property is still under consideration.

The Butte & Superior Co., operating the Black Rock and contiguous mines, is constructing a zinc concentrator near the mine. Plans are for a capacity of 500 tons, which will eventually be increased to 1,000 tons when the mine equipment is improved to handle that quantity of ore. The mine is opened to a depth of 1,600 feet, and mining is being done on the 900-foot, 1,100-foot, 1,200-foot, and 1,400-foot levels. About 500 tons of zinc ore are hoisted daily and sent to the Basin concentrator, which is leased for the treatment of the ore. The zinc deposit is one of the largest in the Western States the drifts being from 30 to 80 feet wide. The Black Rock adjoins the Elm Orlu, the principal zinc-producing property, and the Elm Orlu vein is the extension of the Black Rock vein. On the south, the Black Rock joins the holdings of the North Butte Co. The character of the Black Rock ore makes it ideal for milling and the ores average 20 per cent zinc, 1 per cent iron, 1 per cent lead, 7 ounces of silver, and 0.3 per cent copper. The milling began in January, 1910, the company having leased the Heinze concentrator at Basin and equipped it for the handling of zinc ore. During the two years it has handled 250,000 tons of ore and has made 72,000 tons of zinc concentrates, averaging 20 ounces of silver per ton and 49 per cent zinc. The concentrates are shipped to Bartlesville, Okla., for treatment. The company employs 300 men in its mine and 60 at its mill. The equipment of the new concentrator will consist of a coarse crushing plant separate from the mill proper, in which ore will be crushed to ½-inch size. This will be stored in bins of a capacity of 2,000 tons, located at the head of the concentrator proper, from which it will be drawn as needed, assuring a steady feed in the mill at all times. The concentrator machinery will consist of crushing

[1] Annual report East Butte Copper Mining Co. for year ending Mar. 31, 1912.

rolls, jigs, tables, and a slime plant, which is an adaptation of the Everson-Froment flotation process. Thorough classification will be observed throughout the mill and will be effected in the main by the Richard-Janney classifier. The flotation process has been thoroughly tried at Basin, where it is now making the recovery of 90 per cent on 150 tons of mill tailings every 24 hours. The concentrates made in the flotation plant are of the same grade as those taken from the jigs. The mill will obtain water for its operation from the mine itself, from which is now being pumped about 100 gallons per minute. Additional water needed will be supplied by the Butte Water Co., which is putting in a private 6-inch pipe line to the millsite. There is room at the eastern end of the company's holdings for the discharge of tailings for 15 or 20 years to come.

The Elm Orlu mine produces zinc and copper ore, but has not been operated since the destruction of the Butte Reduction Works, where the zinc ores were concentrated. Plans are in preparation for a new zinc plant. At Butte there are at present two methods[1] of precipitation of copper from mine and tailing water, the box system and the tower system, the latter being generally conceded to be the more successful, as the towers occupy less space and the precipitant is more thoroughly exposed to the water. The box system consists of a series of troughs from 1 to 3 feet wide and 1 foot deep, covering a great deal of surface. The boxes are so arranged that there is a gentle incline and the law of gravity keeps the water in motion. Into these troughs the scrap iron and tin cans are thrown. The copper precipitate, after being washed through the many compartments, sinks to the bottom of the receiving tank, which is cleaned out about once a month. The tower system was introduced about 15 years ago by Huddleston & Turner. The usual tower is about 3 feet wide, 20 feet high, and 30 feet long, and is partitioned off by means of floors 18 inches apart. These floors are made of 2 by 4 inch scantlings, placed 3 inches apart, running lengthwise. Tin cans and scrap iron are placed on the several floors. By means of a small motor the copper water is raised to the top of the tower, where it is distributed equally and constantly over the scrap iron. The tin cans and smaller pieces of iron are dissolved in a comparatively short time, but the larger pieces must be scraped regularly in order to remove the copper precipitate. The latter is washed to the bottom and then into tanks alongside the towers. The operators sell their outputs to the smelters at 4 cents less than the market quotation for copper; the shippers must pay a treatment charge of $5 per ton. The cost of making a pound of copper is estimated at between 7 and 8 cents, so that with the present price of copper there is not a great deal of profit. Theoretically a pound of tin or iron will make its weight in copper. Tin cans are used for the most part where the water is weaker, and iron and steel is sought after by those who have high-grade water. A test made with the same water shows that tin cans made 33 per cent copper precipitate and iron 50 per cent.

The plant at the Original mine has perhaps the most economic system in Butte. Two men take care of 1,400 linear feet of boxes. This company is the first to use the hose washing system, which is very effective. City water, with good pressure, is piped to all parts

[1] Described in the Anaconda Standard, Dec. 10, 1911.

of the boxes, and at regular intervals the precipitate is washed from the half-eaten metal and from the bottom of the boxes. By means of a shelf 2 inches from the bottom of the boxes the precipitate, once it is separated from the metal, is unimpeded in its course to the tanks. This system is so arranged that the copper water may be shut off from any part of the plant. The high-grade precipitate is flushed into tanks 2 by 7 by 9 feet in a steam drying room. There are two tanks, each holding 21 tons and filled several times a month. The open-air tanks hold triple the quantity of those in the steam room. The plants which secure their water direct from the mines and those operated on the sites of abandoned smelters have by far the strongest water with which to work. The water as it comes from the mines averaged from 0.04 to 0.06 per cent copper. With the 0.06 per cent water copper precipitate as high as 90 per cent pure copper is secured, and from this high percentage it runs as low as 30 per cent. Some of the operators are so favored in the location of their plants that they can cause the water to flow through the tailings of the abandoned smelters, thereby materially increasing the efficiency of the water.

The Boston & Montana plant in Meaderville, obtaining its copper water from the two Leonard mines, the West Colusa, and other properties, is one of the largest and most modern copper-precipitating plants in the district. Two flumes, 1,000 feet long and 4½ feet wide, 800 linear feet of boxes, and 4 large towers are operated by this company. The towers are 100 feet long, 30 feet high, and 6 to 8 feet wide. The lower towers have two electric elevators to raise the iron to the top of the towers. The precipitate is dried down to 8 per cent moisture, barreled, and shipped to Great Falls for treatment in 30-ton lots. Three shipments a month is the average output. The average strength of the water is 0.05 per cent of copper. But during the fire that raged several years ago in the underground workings of the West Colusa and other mines, the percentage of the water ran as high as 0.23. While the water was at this great strength, 90 per cent copper precipitates were secured and the average monthly shipment of precipitate was nine carloads. Under normal conditions the precipitate averages 60 per cent. When the fire was raging in these mines city water was poured into them in an endeavor to extinguish the flames. The water thus coming in contact with the sulphide ore and the great heat became highly mineralized.

## NEVADA.

By V. C. Heikes.

### PRODUCTION.

For the calendar year 1911, the gold, silver, copper, lead, and zinc, contained in bullion, ore of shipping grade, and concentrates from the combined mine output of 661 producers in Nevada, had a value of $33,952,529, as against an output valued at $34,152,148, made by 608 producers in 1910. The difference of $199,619 in these totals was caused by a decrease in gold output of $685,467 and in lead of $67,464, which was partly offset by an increase in silver production amounting to $248,709, in copper of $248,547, and in zinc of $56,056.

Mines in Esmeralda County in 1911 made the richest yield, chiefly in gold, according to the total value of metallic output, which

amounted to $11,310,442; this output was recovered from 574,753 tons of ore. Nye County was next in value, chiefly in silver, amounting to $9,404,365, recovered from 525,489 tons of ore. White Pine County followed with a mine output, chiefly in copper, valued at $8,916,621, from 2,778,607 tons of ore. Humboldt County mines produced 9,665 tons of ore, with its principal values in gold, which, with silver, copper, and lead, amounted to $1,363,789. Storey County producers yielded 95,894 tons of ore, containing gold and silver only, valued at $1,304,892.

At gold and silver mills, 1,222,585 tons of ore, or 29.58 per cent of the total ore mined, was treated by the amalgamation and cyanidation processes, by which were recovered 729,252.33 ounces of gold, or 82.86 per cent of the State total, and 7,165,892 ounces of silver, or 54.35 per cent of the total. Smelters treated 269,709 tons of concentrates, from which were recovered 81,097.61 ounces of gold, 2,581,229 ounces of silver, 65,279,799 pounds of copper, 692,180 pounds of lead, and 210,257 pounds of zinc, with a combined value of $11,247,595. The smelters also treated 109,119 tons of crude ore, containing 59,569.92 ounces of gold, 3,432,407 ounces of silver, 2,094,393 pounds of copper, 2,571,477 pounds of lead, and 3,337,775 pounds of zinc, with a value of $3,618,364. Therefore the smelters received ore and concentrates containing 15.98 per cent of the gold, 45.61 per cent of the silver, all of the copper, lead, and zinc, and 44 per cent of the total value of the deep mine output.

The statement of production for 1910 and 1911 showing increase and decrease and valued at each year's commercial prices is as follows:

*Mine production of gold, silver, copper, lead, and zinc in Nevada in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 913,265.05 | $18,878,864 | 880,105.58 | $18,193,397 | −33,159.47 | − $685,467 |
| Silver.....do.... | 12,479,871 | 6,739,130 | 13,184,601 | 6,987,839 | + 704,730 | + 248,709 |
| Copper.....pounds.. | 64,359,398 | 8,173,643 | 67,377,518 | 8,422,190 | + 3,018,120 | + 248,547 |
| Lead.....do.... | 4,871,130 | 214,329 | 3,263,657 | 146,865 | − 1,607,473 | − 67,464 |
| Zinc.....do.... | 2,707,071 | 146,182 | 3,548,032 | 202,238 | + 840,961 | + 56,056 |
| Total..... | ..... | 34,152,148 | ..... | 33,952,529 | ..... | − 199,619 |

Statistics of Nevada's ore output and its metallic content produced during the last eight years are as follows:

*Ore sold or treated in Nevada in 1904–1911, and total content of gold, silver, copper, lead, and zinc.*

| Year. | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine oz.* | *Fine oz.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1904..... | 323,670 | 244,801.18 | 4,268,123 | 29,317 | 4,229,727 | ..... | $7,658,216 |
| 1905..... | 432,202 | 254,927.51 | 6,482,081 | 413,235 | 3,457,124 | 697,757 | 9,453,114 |
| 1906..... | 496,307 | 506,520.31 | 6,770,611 | 1,625,985 | 3,823,617 | 2,886,328 | 15,714,841 |
| 1907..... | 723,581 | 585,311.14 | 7,083,603 | 1,782,571 | 6,271,341 | 2,168,783 | 17,591,486 |
| 1908..... | 1,425,532 | 549,682.27 | 9,508,464 | 15,598,788 | 7,245,619 | 1,115,851 | 18,818,228 |
| 1909..... | 2,982,607 | 785,608.21 | 10,981,061 | 57,976,477 | 9,840,791 | 3,013,352 | 30,072,932 |
| 1910..... | 3,655,775 | 913,265.05 | 12,479,871 | 64,359,398 | 4,871,130 | 2,707,071 | 34,152,148 |
| 1911..... | 4,132,721 | 880,105.58 | 13,184,601 | 67,377,518 | 3,263,657 | 3,548,032 | 33,952,529 |

ORE PRODUCTION IN 1911.

The quantity of ore mined in Nevada and sold or treated increased from 3,655,775 tons in 1910 to 4,132,721 tons in 1911. The total average value decreased from $9.30 to $8.16 per ton and the gold and silver value from $6.96 to $6.04. Sixteen counties in Nevada have producing mines, and all except three produced increased quantities of ore. The ore increase was 476,946 tons, nearly all of which was the increase of White Pine County, at Ely, where steam-shovel mining enables the operators to handle large quantities of low-grade copper ores, which amounted to two-thirds of the ore mined in 1911. There were increases made in output of dry or siliceous ores from 1,258,394 tons mined in 1910 to 1,341,495 tons in 1911; in copper ores from 2,375,490 tons to 2,778,325 tons; and in lead-zinc ores from 1,663 tons to 4,654 tons. Most of the siliceous ores were produced in Esmeralda County, credited with 573,745 tons, and Nye County, with 525,471 tons, each yielding from the mines larger quantities in 1911 than in 1910. Storey County mines produce siliceous gold and silver ores entirely, and though this county ranked third, with a production of 95,894 tons, the yield was 12,698 tons less than in 1910.

Milling ores aggregated 3,974,137 tons, which is over nine-tenths of the total ore mined, and the remainder, 109,119 tons, was shipped directly to the smelters. Of the total milling ore, 1,222,585 tons were treated by amalgamation and cyanidation processes and the remainder, 2,751,552 tons, by concentration alone. Of the total dry or siliceous ores mined, 884,019 tons, valued for the gold and silver content, were produced in 11 counties and averaged per ton $16.96 in gold, 1.29 ounces of silver, 0.04 pound of copper, and 0.02 pound of lead. Practically none of these ores were sulphides. Silver ores, classified under the heading of dry or siliceous ores, aggregated 457,476 tons, averaging per ton $5.50 in gold, 25.56 ounces of silver, 0.05 pound of copper, and 0.25 pound of lead, and were produced in 14 counties. Mines in Tonopah district, Nye County, yielded 404,368 tons of dry or siliceous silver ores, and in Pioche district, Lincoln County, 23,623 tons of oxidized iron-manganese ores, which made about half of the remaining tonnage.

Lead-ore production decreased in quantity from 76,837 tons in 1909 to 16,805 tons in 1910, and again to 5,018 tons in 1911. This decrease for two successive years was caused chiefly by the closing of the lead mines in Eureka County by the floods, which washed out the Eureka & Palisade Railroad, connecting with the Southern Pacific at Palisade. The output of copper-lead ore decreased from 385 tons in 1910 to 216 tons in 1911, and that of zinc ore from 3,038 tons to 3,013 tons. The total average yield per ton of gold and silver in dry or siliceous ores in 1911 was $18.12 against $19.51 in 1910; in copper ore, $0.18 against $0.21 in 1910; in lead ore, $23.38 against $23.62 in 1910; in zinc ore, $1.62 against $0.96 in 1910; in copper-lead ore, $28.67 against $17.19 in 1910; and in lead-zinc ore, $3.81 against $1.97 in 1910. The table following gives the number of mines from which was produced each kind of ore, with metallic content, in Nevada, in 1911.

*Output of ore and production of metals in Nevada in 1911, by kinds of ore.*

| Source of production. | Number of producers. | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Placers | 72 | ..... | 10,181.05 | 4,536 | ..... | ..... | ..... |
| Siliceous ore | 476 | 1,341,495 | 847,124.81 | 12,830,194 | 55,134 | 139,324 | ..... |
| Copper ore | 23 | 2,778,325 | 21,841.27 | 111,474 | 67,286,120 | ..... | ..... |
| Lead ore | 29 | 5,018 | 895.66 | 186,485 | 11,856 | 1,718,250 | ..... |
| Zinc ore | 8 | 3,013 | .29 | 9,216 | 764 | 180,910 | 1,949,898 |
| Copper-lead ore | 9 | 216 | 47.60 | 9,826 | 23,644 | 73,423 | ..... |
| Lead-zinc ore | 3 | 4,654 | 14.89 | 32,870 | ..... | 1,151,750 | 1,598,134 |
| Total | ..... | 4,132,721 | 880,105.58 | 13,184,601 | 67,377,518 | 3,263,657 | 3,548,032 |

Each class of ore produced from the mines in 16 counties is given as follows:

*Subdivision of tonnage of ore sold or treated in Nevada in 1911, by counties, in short tons.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|
| Churchill | 19,463 | ..... | ..... | ..... | ..... | ..... | 19,463 |
| Clark | 2,634 | 513 | 254 | 3,013 | 67 | 4,654 | 11,135 |
| Douglas | 27 | ..... | 11 | ..... | ..... | ..... | 38 |
| Elko | 26,696 | 49 | 134 | ..... | 67 | ..... | 26,946 |
| Esmeralda | 573,745 | 779 | 229 | ..... | ..... | ..... | 574,753 |
| Eureka | 15,424 | ..... | 191 | ..... | 19 | ..... | 15,634 |
| Humboldt | 9,445 | 31 | 189 | ..... | ..... | ..... | 9,665 |
| Lander | 15,857 | ..... | 313 | ..... | ..... | ..... | 16,170 |
| Lincoln | 23,874 | ..... | 1,769 | ..... | ..... | ..... | 25,643 |
| Lyon | 16,734 | 11 | ..... | ..... | ..... | ..... | 16,745 |
| Mineral | 9,587 | 26 | 1,210 | ..... | 6 | ..... | 10,829 |
| Nye | 525,471 | 15 | 3 | ..... | ..... | ..... | 525,489 |
| Ormsby | 1,715 | 12 | ..... | ..... | ..... | ..... | 1,727 |
| Storey | 95,894 | ..... | ..... | ..... | ..... | ..... | 95,894 |
| Washoe | 3,908 | 11 | 64 | ..... | ..... | ..... | 3,983 |
| White Pine | 1,021 | 2,776,878 | 651 | ..... | 57 | ..... | 2,778,607 |
| Total | [a] 1,341,495 | 2,778,325 | 5,018 | 3,013 | 216 | 4,654 | 4,132,721 |
| Average value per ton in gold and silver | $18.12 | $0.18 | $23.38 | $1.62 | $28.67 | $3.81 | $6.04 |

[a] Includes 884,018 tons of gold and gold-silver ores, and 457,476 tons of silver ores, of which 23,623 tons were oxidized iron-manganese ores.

## GOLD.

The output of gold decreased from 913,265.05 fine ounces, valued at $18,878,864 in 1910, to 880,105.58 fine ounces, valued at $18,193,397 in 1911. The largest decrease, or $850,075, in gold, was made by the mines in the Goldfield district, whose yield in gold was $11,137,150 in 1910 and $10,287,075 in 1911. Added to this decrease was that of Humboldt County, of $234,772 in gold, due to the lessened output of the National mines. These decreases were largely offset by gains in several counties, Storey County increasing its gold yield $474,506. Decreases were also made in Clark, Mineral, Nye, Lincoln, White Pine, and Lyon counties. Sixty-one placer and surface mines worked by hydraulic and sluicing methods, 2 by dredges and 9 by drift mining, produced $210,461 in gold, which was $48,090 greater than in the output of 1910. Most of the placer gold in both years was produced at Manhattan and at Round Mountain, in Nye County. The

largest single gold output in Nevada in 1911 was made from the Goldfield Consolidated mines; other important producers were the mines at Tonopah, in Nye County. The combined gold production of Esmeralda, Nye, and Humboldt counties amounted to $16,039,592, which is nearly nine-tenths of the gold total for the State. In the three counties amalgamation and cyanidation processes were used to recover 688,885.05 ounces, of which the amalgamation process produced bullion containing 204,933.75 ounces of gold, and the cyanidation process 483,951.30 ounces. Concentrates produced at milling plants contained 81,097.61 ounces of gold, of which Storey County was credited with the largest yield, or 22,914.50 ounces of gold, followed by Esmeralda with 16,642.16 ounces, and by Nye County with 15,230.46 ounces. The greater part of the gold was contained in concentrates of iron and rich silver sulphides containing a little copper. Altogether there were produced from dry or siliceous concentrates 60,276.73 ounces of gold, and from copper concentrates 20,625.91 ounces. Lead concentrate yielded only 157.21 ounces of gold, and copper-lead concentrate 37.76 ounces of gold. Crude ores shipped directly to smelters contained 59,569.92 ounces of gold. The largest amounts were credited to Nye County, with 29,855.17 ounces of gold, and to Storey County, with 13,473.40 ounces of gold. The siliceous ores were valued as converter lining or flux, and 67,584 tons contained 57,515.56 ounces of gold; 32,789 tons of copper ores contained 1,210.70 ounces of gold; and 3,180 tons of lead ores contained 781.79 ounces of gold. Smaller amounts of gold were contained in copper-lead and lead-zinc ores.

*Source of gold production in Nevada in 1911, by kinds of ore, by counties, in fine ounces.*

| County. | Placers. | Deep mines. | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|
| | | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | |
| Churchill | | 5,998.02 | | | | | | 5,998.02 |
| Clark | | 1,166.98 | 3.74 | 2.08 | 0.29 | 41.41 | 14.90 | 1,229.40 |
| Douglas | 56.70 | 24.84 | | .12 | | | | 81.66 |
| Elko | 57.32 | 4,413.72 | 3.43 | 5.48 | | .40 | | 4,480.35 |
| Esmeralda | 2.57 | 540,845.24 | 744.51 | 140.05 | | | | 541,732.37 |
| Eureka | 443.12 | 4,837.33 | | 110.17 | | | | 5,390.62 |
| Humboldt | 255.42 | 58,845.94 | 4.67 | 91.14 | | | | 59,197.17 |
| Lander | 343.07 | 2,849.21 | | 168.28 | | | | 3,360.56 |
| Lincoln | | 105.08 | | 261.70 | | | | 366.78 |
| Lyon | 24.62 | 5,218.41 | 4.25 | | | | | 5,247.28 |
| Mineral | 324.06 | 4,648.24 | 4.73 | 39.16 | | 3.88 | | 5,020.07 |
| Nye | 8,631.55 | 166,339.43 | 1.41 | 13.33 | | | | 174,985.72 |
| Ormsby | 42.62 | 873.54 | 18.25 | | | | | 934.41 |
| Storey | | 47,279.26 | | | | | | 47,279.26 |
| Washoe | | 3,205.72 | .86 | .30 | | | | 3,206.88 |
| White Pine | | 473.85 | 21,055.42 | 63.85 | | 1.91 | | 21,595.03 |
| Total | 10,181.05 | [a] 847,124.81 | 21,841.27 | 895.66 | .29 | 47.60 | 14.90 | 880,105.58 |

[a] Includes 725,479.63 ounces from gold and gold-silver ores, and 121,645.18 ounces from silver ores, of which 26.30 ounces were from oxidized iron-manganese ores.

## SILVER.

Silver production increased from 12,479,871 ounces in 1910 to 13,184,601 ounces in 1911, and in value from $6,739,130 to $6,987,839. The greatest part of the silver output, or 10,918,263 ounces in quantity, was made in Nye County, an increase of 367,960 ounces over the production of 1910. The yield also increased in Storey, Churchill,

and Lincoln counties. The largest silver producer was the Belmont mine, at Tonopah, with the Tonopah Mining Co. a close second. Milling plants in Nevada using amalgamation and cyanide processes produced bullion containing 7,165,892 ounces of silver, of which 168,633 ounces were recovered by amalgamation and 6,997,259 ounces by cyanidation. The two counties having the largest yield of silver by amalgamation were Humboldt and Mineral counties; by cyanidation, Nye County, with 6,375,380 ounces, followed by Churchill County, with 371,289 ounces. At concentration mills, concentrates were produced containing 2,581,229 ounces of silver, the largest part of which, or 2,428,099 ounces, was contained in dry or siliceous concentrates. About nine-tenths of the silver in these concentrates was produced after the recovery of the gold and silver bullion and before cyanide treatment. There were 25,970 tons of dry or siliceous concentrates produced at gold and silver mills, averaging 92 ounces of silver per ton, and 243 tons from concentration mills, averaging 160.03 ounces of silver per ton. Mills in Nye County produced most of this class of concentrate. Copper concentrate aggregating 242,099 tons contained 97,232 ounces of silver, and was all produced in White Pine County. Lead concentrate, of which 921 tons were produced, contained 52,459 ounces, 446 tons of zinc concentrate contained 2,887 ounces, and 30 tons of copper-lead concentrate contained 552 ounces. Silver was contained in largest quantities in dry or siliceous ores of smelting grade, which amounted to 67,584 tons, containing 3,234,107 ounces of silver and averaging 47.85 ounces per ton. Nearly all of this ore was shipped from mines in Nye County. Lead ores carried the next largest total of 145,634 ounces from 3,180 tons of ore, an average of 45.80 ounces per ton. The smallest silver average was from copper ores of smelting grade, which contained 0.42 ounce per ton; whereas zinc ores averaged 3.06 ounces per ton; copper-lead ores, 45.49 ounces per ton; and lead-zinc ore, 8.52 ounces per ton.

*Source of silver production in Nevada in 1911, by kinds of ore, by counties, in fine ounces.*

| County. | Placers. | Deep mines. | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|
| | | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | |
| Churchill | ..... | 456,066 | ..... | ..... | ..... | ..... | ..... | 456,066 |
| Clark | ..... | 5,380 | 2,767 | 4,792 | 9,216 | 618 | 32,870 | 55,643 |
| Douglas | 11 | 19 | ..... | 107 | ..... | ..... | ..... | 137 |
| Elko | 41 | 24,861 | 256 | 2,055 | ..... | 3,204 | ..... | 30,417 |
| Esmeralda | 1 | 173,497 | 4,370 | 7,085 | ..... | ..... | ..... | 184,953 |
| Eureka | 30 | 2,281 | ..... | 12,085 | ..... | 877 | ..... | 15,273 |
| Humboldt | 134 | 245,170 | 552 | 9,511 | ..... | ..... | ..... | 255,367 |
| Lander | 67 | 154,755 | ..... | 5,858 | ..... | ..... | ..... | 160,680 |
| Lincoln | ..... | 155,033 | ..... | 19,741 | ..... | ..... | ..... | 174,774 |
| Lyon | 13 | 7,815 | 11 | ..... | ..... | ..... | ..... | 7,839 |
| Mineral | 271 | 59,529 | 127 | 104,674 | ..... | 1,207 | ..... | 165,808 |
| Nye | 3,843 | 10,911,668 | 2,697 | 55 | ..... | ..... | ..... | 10,918,263 |
| Ormsby | 125 | 7,458 | 25 | ..... | ..... | ..... | ..... | 7,608 |
| Storey | ..... | 618,006 | ..... | ..... | ..... | ..... | ..... | 618,006 |
| Washoe | ..... | 5,568 | 286 | 5,228 | ..... | ..... | ..... | 11,082 |
| White Pine | ..... | 3,088 | 100,383 | 15,294 | ..... | 3,920 | ..... | 122,685 |
| Total | 4,536 | [a]12,830,194 | 111,474 | 186,485 | 9,216 | 9,826 | 32,870 | 13,184,601 |

[a] Includes 1,138,414 ounces from gold and gold-silver ores, and 11,691,780 ounces from silver ores of which 154,530 ounces were from oxidized iron manganese ores.

## COPPER.

Copper was produced in 13 counties in Nevada and aggregated 67,377,518 pounds, valued at $8,422,190, in 1911, as against a yield of 64,359,398 pounds, valued at $8,173,643, in 1910. White Pine County mines, mainly those at Ely, yielded 67,035,361 pounds of the copper in 1911, an increase of 3,105,083 pounds over the production of 1910. Clark County was the next in production, with 185,915 pounds in 1911 as against 216,773 pounds in 1910. Concentrates produced at milling plants contained most of the copper, or 65,279,799 pounds, and averaged 13.48 per cent of copper. Dry or siliceous concentrate contained 12,575 pounds of copper, most of it from concentrate residues from the gold and silver mills.

*Source of copper production in Nevada in 1911, by kinds of ore, by counties, in dry pounds.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Total. |
|---|---|---|---|---|---|---|
| Clark | ..... | 173,820 | 333 | 764 | 10,998 | 185,915 |
| Elko | 13 | 11,980 | 188 | ..... | 4,188 | 16,369 |
| Esmeralda | 34,071 | 42,712 | 3,694 | ..... | ..... | 80,477 |
| Eureka | ..... | ..... | 1,501 | ..... | 1,116 | 2,617 |
| Humboldt | 373 | 10,558 | 1,048 | ..... | ..... | 11,979 |
| Lander | 4,583 | ..... | 1,475 | ..... | ..... | 6,058 |
| Lincoln | 15,247 | ..... | 2,135 | ..... | ..... | 17,382 |
| Lyon | ..... | 2,727 | ..... | ..... | ..... | 2,727 |
| Mineral | 301 | 11,000 | 100 | ..... | 1,467 | 12,868 |
| Nye | 445 | 1,801 | 18 | ..... | ..... | 2,264 |
| Ormsby | ..... | 1,526 | ..... | ..... | ..... | 1,526 |
| Washoe | 34 | 1,656 | 285 | ..... | ..... | 1,975 |
| White Pine | 67 | 67,028,340 | 1,079 | ..... | 5,875 | 67,035,361 |
| Total | [a] 55,134 | 67,286,120 | 11,856 | 764 | 23,644 | 67,377,518 |

[a] Includes 33,314 pounds from gold and gold-silver ores, and 21,820 pounds from silver ores of which 15,247 pounds came from oxidized iron-manganese ore.

## LEAD.

The lead production in 1911 aggregated 3,263,657 pounds, valued at $146,865. Compared with the output of 1910, this is a decrease of 1,607,473 pounds and $67,464 in value. Clark County mines made the largest output, or 1,629,571 pounds, followed by White Pine County with 572,654 pounds and by Lincoln County with 455,490 pounds. Half of the lead yield, or 1,530,591 pounds, was contained in lead ores shipped directly to the smelters and averaged 481.32 pounds per ton. The next largest yield was from lead-zinc ores shipped directly to smelters, containing 693,534 pounds, or an average of 296.76 pounds per ton. Copper-lead ores contained 73,423 pounds, or 339.92 pounds per ton. Concentrates produced at mills in Clark County yielded 458,216 pounds of lead, with Lincoln County ranking next in output with 106,146 pounds. There were 921 tons of lead concentrate produced, containing 525,121 pounds of lead; 26 tons, averaging 180.4 pounds per ton, at plants connected with gold and silver mills; and 895 tons, averaging 581.4 pounds per ton, at plants where concentration methods were used exclusively. Zinc concentrate, aggregating 446 tons, yielded 139,003 pounds of lead, or 311.6 pounds per ton. Only 30 tons of copper-lead concentrate were produced and contained an average of 759.2 pounds per ton.

*Source of lead production in Nevada in 1911, by kinds of ore, by counties, in dry pounds.*

| County. | Dry or siliceous ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|
| Churchill | 117 | | | | | 117 |
| Clark | 32 | 289,220 | 180,910 | 7,659 | 1,151,750 | 1,629,571 |
| Douglas | | 5,404 | | | | 5,404 |
| Elko | | 54,142 | | 40,134 | | 94,276 |
| Esmeralda | 9,889 | 73,529 | | | | 83,418 |
| Eureka | 12,249 | 37,877 | | 11,010 | | 61,136 |
| Humboldt | 10,804 | 61,046 | | | | 71,850 |
| Lander | 23,403 | 42,739 | | | | 66,142 |
| Lincoln | 70,473 | 385,017 | | | | 455,490 |
| Mineral | 10,152 | 171,645 | | 2,865 | | 184,662 |
| Nye | 1,756 | 1,052 | | | | 2,808 |
| Washoe | 4 | 36,125 | | | | 36,129 |
| White Pine | 445 | 560,454 | | 11,755 | | 572,654 |
| Total | [a] 139,324 | 1,718,250 | 180,910 | 73,423 | 1,151,750 | 3,263,657 |

[a] Includes 21,904 pounds from gold and gold-silver ores, and 117,420 pounds from silver ores of which 70,473 pounds were from oxidized iron-manganese ores.

## ZINC.

The output of zinc, calculated as spelter, aggregated 3,548,032 pounds, valued at $202,238, in 1911, against a yield of 2,707,071 pounds in quantity and of $146,182 in value in 1910. All of the metal is the output of Clark County, from mines in the Yellow Pine district, which produced 3,013 tons of zinc ore of shipping grade, estimated to produce an average of 647.20 pounds of spelter per ton, and 2,337 tons of lead-zinc ore, yielding spelter averaging 593.87 pounds per ton. Concentrates aggregating 446 tons yielded spelter averaging 471.41 pounds per ton. The ore shipments direct to the smelters consisted of zinc carbonate and silicate and a mixed zinc-lead-silver ore.

*Source of zinc production in Nevada in 1911, by kinds of ore, by counties, in dry pounds.*

| County. | Zinc ore. | Lead-zinc ore. | Total. |
|---|---|---|---|
| Clark | 1,949,898 | 1,598,134 | 3,548,032 |

## REDUCTION MILLS.

The following list shows the reduction mills in Nevada in 1911:

*List of reduction mills in Nevada in 1911, by counties.*

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| CHURCHILL COUNTY. | | | | *Short tons.* |
| Nevada Hills [a] | Fairview | Concentration, cyanidation. | Blake crusher, 20 stamps, tube mill, tables, cyanide tanks. | 125 |
| Nevada Wonder [a] | Wonder | Cyanidation | 1 Blake crusher, Chilean mill, tube mill, table, 10 stamps, 4 cyanide tanks (350 tons). | 100 |
| Atlas Wonder [b] | do | Concentration, cyanidation. | | 100 |

[a] Active in 1911. [b] Under construction in 1911.

*List of reduction mills in Nevada in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| CLARK COUNTY. | | | | *Short tons.* |
| Davis Russell [a] | Crescent | Amalgamation, concentration. | 1 stamp (Nissen), plate, tables. | 4 |
| Queen [a] | El Dorado Canyon. | Amalgamation, cyanidation. | 1 crusher, 3 stamps, Huntington mills, 6 cyanide tanks. | 30 |
| Eldorado Occidental [a] | do | Cyanidation | 5 cyanide tanks (40 tons each), one 5-foot Bryan roller mill. | 25 |
| Gold Cross e. a. [b] | Gold Butte | Amalgamation, concentration. | | 5 |
| Cyrus Noble (custom) [a] | Searchlight | do | 10 stamps, plates, and tables. | 30 |
| Homestead [b] | do | Cyanidation | 3 stamps and tanks | 15 |
| Quartette [a] | do | Amalgamation, cyanidation. | 40 stamps, plates, 5 cyanide tanks (150 tons). | 135 |
| Pompeii [b] | do | Amalgamation | 10-stamp mill and plates. | 30 |
| Peerless [a] | do | Amalgamation, cyanidation. | 10 stamps, 12 tanks, and 50-ton cyanide plant. | 30 |
| Yellow Pine [a] | Yellowpine | Concentration | Crusher, rolls, jigs, separation of lead and zinc, tables, and classifiers. | 80 |
| Lucy Gray [a] | do | Concentration, cyanidation. | Chilean mill, tables, tanks. | 20 |
| DOUGLAS COUNTY. | | | | |
| Pine Nut [a] | Gardnerville | Amalgamation, concentration. | 5 stamps, Chilean mill, tables. | 50 |
| Longfellow [b] | Red Canyon | do | Test mill, 7 stamps | 5 |
| ELKO COUNTY. | | | | |
| Lucky Girl [b] | Centennial | Amalgamation, concentration, cyanidation. | Crusher, 20 stamps, tables, and 9 tanks. | 60 |
| Aura [b] | Aura | Amalgamation, concentration. | 5 stamps | 15 |
| Golden Chariot [b] | Gold Circle | Amalgamation | | 4 |
| Charles Geyman [b] | do | do | 10 stamps and plates | 10 |
| Rex [a] | do | Cyanidation | Crusher, 5 stamps, tube mill, 7 cyanide tanks (77,000 gallons), agitator. | 40 |
| Black Warrior [b] | Charleston | do | 5 stamps and tanks | 10 |
| Jarbidge Pavlak [a] | Jarbidge | Amalgamation, cyanidation. | Crushers, Chilean mills, copper plates, 2 Dorr classifiers, slime tank, and agitators. | 75 |
| North Star [a] | do | Amalgamation, concentration. | Crusher, rolls, Hardinge mill, plates, tables. | 75 |
| Dexter [a] | Tuscarora | Cyanidation | Crushers, 40 stamps, 7 tanks, 420-ton tailing plant. | 100 |
| Protection [a] | Vanduser | Amalgamation, concentration. | Crusher, 10 stamps, plates, and tables. | 30 |
| ESMERALDA COUNTY. | | | | |
| Nevada-Goldfield Reduction Works (custom). [a] | Goldfield | Amalgamation, concentration, cyanidation. | 20 stamps, filter plant, Wilfley tables, classifiers. | 150 |
| Goldfield Chlorination [b] | do | Chlorination | | 200 |
| Goldfield Consolidated [a] | do | Amalgamation, concentration, cyanidation. | Crushers, 100 stamps, 6 Dorr classifiers, 6 Chilean mills, 6 tube mills, 94 tables, 16 dewatering tanks, 10 Pachuca agitators. | 950 |
| Florence-Goldfield [a] [c] | do | Amalgamation, cyanidation. | 40 stamps and cyanide plant. | 160 |

[a] Active in 1911. [b] Idle in 1911. [c] Mill destroyed by fire, December, 1911.

*List of reduction mills in Nevada in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| ESMERALDA COUNTY—continued. | | | | *Short tons.* |
| New Bonnie Claire [a] | Gold Mountain | Amalgamation, concentration, cyanidation. | Crusher, 20 stamps, tube mill, Frue vanners, five 150-ton cyanide tanks, Dorr classifier. | 100 |
| Liberty Bell [b] | do | Amalgamation | Crusher and Hathaway mill. | 36 |
| Pigeon Springs [c] | Lida | Amalgamation, concentration. | 10 stamps, plates, tables. | ..... |
| Pittsburg-Silver Peak [c] | Silver Peak | Amalgamation, cyanidation. | Crusher, 120 stamps, plates, sand vats, tube mill, Dorr classifier, five 500-ton leaching tanks. | 500 |
| Red Mountain [c] | do | do | 10 stamps and 50-ton cyanide plant. | 60 |
| EUREKA COUNTY. | | | | |
| Windfall [c] | Eureka | Cyanidation | 1 crusher, 3 rolls, 8 tanks. | 150 |
| Lincoln [b] | do | Concentration | ..... | 40 |
| Silver Conner [c] | do | Cyanidation | 10 stamps, tube mill, and cyanide plant. | 80 |
| Mineral Hill [b] | Mineral Hill | Concentration, cyanidation. | 2 crushers, 10 stamps, 9 tanks (300 tons). | 200 |
| HUMBOLDT COUNTY. | | | | |
| Gold Ledge [c] | Gold Run | Amalgamation | 6-foot Lane slow-speed mill. | 30 |
| Nevada-Superior [a] | Antelope | Concentration | Crusher, rolls, jigs, Wilfley and slime tables. | 75 |
| Black Hole [c] | Dun Glen | Amalgamation | 5 stamps and plates | 20 |
| Imlay [b] | Imlay | Amalgamation, concentration. | 10 stamps and tables | 30 |
| Boulaska and Klondike [b] | Kennedy | Amalgamation, cyanidation. | 1 crusher, 20 stamps, plates, classifiers, 11 cyanide tanks. | 100 |
| National [c] | National | Amalgamation, concentration. | Crusher, 5 stamps, plates, and tables. | 30 |
| Bodenia [c] | Paradise | Amalgamation | Rolls and sluice boxes. | 1 |
| Bullion [b] | do | Amalgamation, concentration. | 10 stamps | 40 |
| Comet [a] | Rosebud | Amalgamation | Sluicing plant | 100 |
| Mazuma [b] | Seven Troughs | Amalgamation, concentration. | 10 stamps, plates, and Wilfley tables. | 25 |
| Seven Troughs Coalition. [c] | do | Amalgamation, concentration, cyanidation. | 10 stamps, plates, and tables. | 40 |
| Darby Custom [c] | do | do | 10 stamps, tube mill, tables, and slimers. | 50 |
| Spring City [c] | Paradise | Cyanidation | Tanks | 50 |
| Humboldt King [b] | Spring Valley | do | ..... | 5 |
| Arizona [c] | Unionville | Amalgamation, concentration, cyanidation. | 2 stamps, plates, tube mills, and tanks. | 40 |
| LANDER COUNTY. | | | | |
| Cortez (old) [b] | Galena | Chlorination | ..... | 30 |
| Cortez Metal Recovery Co. [c] | do | Cyanidation | Crusher, rolls, and tanks. | 100 |
| Pittsburg Red Top [a] | Hilltop or Kimberly. | Concentration | Crusher, Ellspass mill, Isbell separator. | 80 |
| Peterson [c] | Jackson | Amalgamation | 3 stamps and plates | 2 |
| Austin-Manhattan [c] | Reese River | Concentration (dry) | 2 crushers, 2 tables, classifier, 6 Huff electrostatic separators. | 35 |
| Bunker Hill [b] | do | Concentration | 30 stamps | 100 |
| Kingston [c] | do | Concentration, cyanidation. | 30 stamps, 4 cyanide tanks (200 tons). | 60 |
| Giant [a] | Battle Mountain | Concentration | 5 stamps | 20 |

[a] Under construction in 1911. [b] Idle in 1911. [c] Active in 1911.

*List of reduction mills in Nevada in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| LINCOLN COUNTY. | | | | *Short tons.* |
| Midnight and Homestake.[a] | Eagle Valley | Amalgamation, cyanidation. | Crusher, Chilean mill, 11 cyanide tanks (280 tons). | 25 |
| Horseshoe[a] | do | do | Crushers, Monadnock mills, plates, and 9 cyanide tanks (90 tons). | 100 |
| White Horse[b] | do | Hyposulphite | Crushers, rolls, small leaching plant. | 4 |
| Poorman[b] | Pioche | Concentration | Jigs | |
| H. T. Wheeler[a] | do | do | 5 stamps, jigs, and tables. | 20 |
| Gold Chief[b] | Caliente or Chief | Cyanidation | Crusher, rolls, tanks for simple percolation. | 20 |
| LYON COUNTY. | | | | |
| Ramsey Comstock[a] | Ramsey | Amalgamation, concentration. | | 40 |
| Ida-Santiago[b] | Silver City | Amalgamation | 18 stamps and plates | |
| Buckeye[b] | do | Cyanidation | Tanks for simple percolation. | 30 |
| Rock Point[b] | do | Amalgamation, concentration. | 2 crushers, 40 stamps, plates, and tables. | 200 |
| North Rapidan[a] | do | Concentration | 10 stamps | 30 |
| Silver City[a] | do | Amalgamation | Bryan mill, plates, pans. | 30 |
| Vivian[b] | do | do | 20 stamps | |
| Como-Eureka[b] | do | Amalgamation, concentration, cyanidation. | 1 crusher, 10 stamps, Pachuca agitators, Dorr classifiers and thickeners. | 70 |
| Pollard (McTigue)[b] | do | Amalgamation | 10 stamps | |
| Blue Stone[a] | Yerington | Concentration | Crusher, rolls, Wetherill magnetic separators. | 75 |
| MINERAL COUNTY. | | | | |
| Baldwin Delmonte[b] | Aurora | Cyanidation | 10 stamps | 30 |
| Oriole[c] | Gold Range | Amalgamation | 5 stamps and plates | 15 |
| Palmico[b] | Hawthorne | do | 20 stamps and plates | 60 |
| Setting Sun[a] | do | do | 2 stamps and plates | 2 |
| Goldfield Alamo[b] | do | Concentration | 10 stamps and tables | 30 |
| Wheeler[b] | Pine Grove | Amalgamation, concentration. | 5 stamps and plates | 15 |
| Wild Horse[b] | do | Amalgamation | Stamps and plates | 15 |
| Queen[b] | Rawhide | Amalgamation, concentration, cyanidation. | 1 crusher, 10 stamps, plates, tables, classifiers, filters, 2 Dorr thickeners, 50-ton cyanide tank. | 40 |
| Black Eagle[b] | do | Amalgamation, cyanidation. | Crusher, rolls, plates, classifier, and slime table. | |
| Weiss[b] | do | Amalgamation, concentration. | 1 crusher, Lane slow-speed mill, table, 20-ton cyanide plant. | 40 |
| Delmonte[b] | Santa Fe | do | Chilean mill, plates, classifiers, tables, Frue vanners. | 25 |
| Walker Lake[b] | Walker Lake | do | 5 stamps, plates, and tables. | 50 |
| NYE COUNTY. | | | | |
| Eclipse[a] | Bullfrog | Amalgamation, cyanidation. | 10 stamps and 50-ton cyanide mill. | 50 |
| Bullfrog Gold Bar[a] | do | Amalgamation | 10 stamps, crusher, and 1 tube mill. | 100 |
| Mayflower Bullfrog[b] | do | Cyanidation | 15 stamps | 30 |
| Montgomery Shoshone[b] | do | Concentration, cyanidation. | 1 crusher, 3 sets rolls, 1 tube mill, Taylor high-speed mill, tables, Frue vanners, 5 sand tanks, and 5 slime tanks. | 200 |

[a] Idle in 1911. [b] Active in 1911. [c] Under construction in 1911.

*List of reduction mills in Nevada in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| NYE COUNTY—cont'd. | | | | *Short tons.* |
| Homestake King [a] | Bullfrog | Cyanidation | 30 stamps, 2 Dorr classifiers and 2 thickeners. | 100 |
| Ophir [a] | Hot Creek | Amalgamation | Crusher and 10 stamps. | 30 |
| Johnnie [b] | Johnnie | do | Crushers, 16 Nissen stamps, slow-speed Lane mill, Chilean mill. | 80 |
| War Eagle (custom) [b] | Manhattan | Amalgamation, cyanidation. | 10 stamps, Dorr classifiers, etc. | 60 |
| Dexter [b] | do | do | 3 crushers, rolls, agitation plant, 10 stamps, tube mill, and Butters filters. | 50 |
| Associated Mill Co. [c] | do | do | 10 stamps | 50 |
| Lemon [a] | do | do | do | 50 |
| Round Mountain [b] | Round Mountain | Amalgamation | 3 crushers, 2 Nissen stamps, 10 Standard stamps, 5-foot Huntington mill, 2 tube mills, and plates. | 200 |
| Solid Gold [b] | do | do | 6 stamps and plates | 30 |
| Fairview [b] | do | do | 5-foot Huntington mill. | 20 |
| Montana Tonopah [b] | Tonopah | Concentration, cyanidation. | Crusher, 40 stamps, Wilfley tables, tube mills, vanners, 1 Trent tank, 6 Hendryx agitators, and 2 Dorr classifiers. | 155 |
| McNamara [c] | do | Cyanidation | Crusher, 10 stamps, rolls, tube mills, agitators, 3 cyanide tanks (250 tons), Dorr thickeners. | 75 |
| Tonopah Extension [b] | do | do | 30 stamps, tube mills, Dorr classifiers, Trent agitators, Butters filters. | 140 |
| Tonopah Belmont [b] | Old mill at Millers. | Concentration, cyanidation. | 10 crushers, 60 stamps, 2 tube mills, 12 Wilfley tables, 19 cyanide tanks, 8 Dorr thickeners, 8 Dorr classifiers. | 300 |
| Tonopah Belmont [c] | New mill at Tonopah. | do | 60 stamps, 8 tube mills, 12 Wilfley tables, Pachuca agitators, and Dorr classifiers. | 500 |
| Tonopah [b d] | Tonopah | Concentration | Crushers, 100 stamps, tables, and slime agitators. | 500 |
| Tonopah Liberty [b] | do | Cyanidation | All slime plant, Dorr classifier, etc. | 100 |
| West End [b] | do | Concentration, cyanidation. | 2 crushers, 20 stamps, 2 tube mills, 12 tables, 4 Trent agitators, and 1 Dorr thickener. | 115 |
| Berlin [b] | Union | Amalgamation, concentration. | 30 stamps, plates, and 10 Frue vanners. | 100 |
| ORMSBY COUNTY. | | | | |
| Brunswick [b] | Carson River | Amalgamation | Sluice boxes for sluicing tailings and recovery of amalgam. | ..... |
| Morgan [b] | do | Cyanidation | Tanks for simple percolation. | ..... |
| Mexican [b] | do | Amalgamation | Sluice box for sluicing tailings and recovery of amalgam. | ..... |
| Athens [b] | Washoe and Eagle Valley. | do | 3 stamps and plate | 5 |

[a] Idle in 1911.
[b] Active in 1911.
[c] Under construction in 1911.
[d] See article on mill in Eng. and Min. Jour., June 17, 1911.

*List of reduction mills in Nevada in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| STOREY COUNTY. | | | | *Short tons.* |
| Gold Canyon [a] | Comstock | Cyanidation | Stamps | 50 |
| Butters [b] | do | Concentration, cyanidation. | 20 stamps, 4 tube mills, 6 Frue vanners, 2 Dorr classifiers, Butters filters. | 160 |
| Pfeifer [b] | do | Concentration | 5 stamps and tables | 15 |
| Justice [b] | do | Amalgamation, concentration. | 10 stamps | 35 |
| Kinkead [a] | do | do | 6 Kinkead mills, 6 Frue vanners. | 60 |
| Wandering Boy [b] | do | Amalgamation | 2 stamps | 2 |
| Mexican [c] | do | Cyanidation | Crusher, 10 stamps, 2 Trent mills, 3 cyanide tanks (70 tons each), Dorr classifiers and thickeners. | 80 |
| James or Fisher [b] | do | Amalgamation, concentration, cyanidation. | 5 stamps, plates, 4 cyanide tanks (100 tons). | 12 |
| Yellow Jacket [b] | do | Amalgamation, concentration. | 20 Kinkead stamps and tables. | 60 |
| WASHOE COUNTY. | | | | |
| Donnelly Mountain [b] | Leadville | Amalgamation concentration. | Crusher, 5 stamps and Diester tables. | 24 |
| Tohoqua [b] | do | Concentration | Crusher, rolls, and jigs. | 50 |
| Bargo [b] | West Comstock | Amalgamation | 10 stamps and plates | 30 |
| Fink Mahoney [b] | do | Concentration | 5 stamps and tables | 15 |
| Emma L [a] | White Horse | Amalgamation | Chilean mill | 40 |
| Slip Custom [b] | do | do | Two 3½-foot Huntington mills and plates. | 30 |
| Green Hills [b] | do | do | 3 stamps and plates | 4 |
| Wedekind [a] | Wedekind | Cyanidation | 2-roll Merrill mill | 50 |
| WHITE PINE COUNTY. | | | | |
| Chief of the Hills [a] | Cherry Creek | Cyanidation | 20-stamp mill with cyanide plant. | 75 |
| Wide West [a] | do | Amalgamation, concentration. | 5 stamps, 1 Dodge crusher, 1 Johnson vanner. | 8 |
| San Pedro [b] | Osceola | do | 10 stamps, plates, tables. | 30 |
| Exchange [b] | do | Amalgamation | | |
| Ohana [c] | do | Amalgamation, concentration. | | 25 |
| Nevada Consolidated [b] | Robinson | Concentration | Crushers, 32 sets rolls, 10 Chilean mills, 24 Huntington mills, 580 Wilfley tables, 24 jigs, 384 vanners, and Dorr thickeners. | 10,000 |
| Giroux [a] | (At Kimberly) | do | Crushers, jigs, and tables. | 500 |

[a] Idle in 1911. [b] Active in 1911. [c] Under construction in 1911.

This list comprises all of the milling plants in Nevada on the United States Geological Survey lists in 1911. Names and a rough summary of equipment for the greater part of the list of 141 plants are given. Of this number, 89 plants were operating in 1911, 40 were idle, and 12 were under construction or being remodeled. There were 32 mills using the amalgamation process, of which 21 were operating; 18 were concentration plants, 9 being in operation; 24 were cyanide plants, 15 being in operation; 27 used amalgamation and concentration methods, and 17 were in operation. The concentration and cyanidation processes combined were used in 11 plants, 8 of them being in operation. Sixteen plants used amalgamation and cyanidation, 10 being active. At 10 plants, amalgamation, concentration, and cyanidation were used, 8 plants being in operation. Two chlorination plants were idle, and the only plant using the hyposulphite process was active a short time in 1911.

Nearly all of the dry or siliceous ores produced in Nevada were treated either by amalgamation or cyanidation, or by both. At several mills the treatment was commenced by crushing in a weak cyanide solution, and at one mill concentration followed amalgamation with a partial leaching of the concentrate and the shipment or smelting of the residue. During 1911 there were treated at amalgamation and cyanide mills, with or without concentration equipment, 1,222,585 tons of ore and 48,413 tons of old tailings. Of the material treated, 781,128 tons of ore and 335 tons of old tailings yielded 224,988.75 ounces of gold and 168,633 ounces of silver by amalgamation, or an average recovery of $5.95 in gold and 0.22 ounce of silver per ton. The tailings averaged $4.87 in gold and 1.16 ounces of silver per ton. Of the amalgamated ore, a part, amounting to 594,348 tons, was given a further treatment by the cyanide process, which, with that directly cyanided, 441,457 tons of ore and 48,078 tons of old tailings, aggregated 1,083,883 tons, yielding 504,413.58 ounces of gold and 7,004,757 ounces of silver. The ore averaged per ton a recovery of $9.99 in gold and 6.68 ounces of silver, and the old tailings, $1.54 in gold and 1.85 ounces of silver.

An effort was made in 1911 to learn what quantity of quicksilver and of the cyanides had been consumed. From reports received, 4,753 pounds of quicksilver were used at amalgamation mills. Cyanide mills consumed 995,324 pounds of potassium cyanide and 1,357,637 pounds of sodium cyanide.

*Tonnage of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Nevada in 1911, by counties.*

| County. | Quantity. | Bullion recovered from ore by— | | | | Total value. |
|---|---|---|---|---|---|---|
| | | Amalgamation. | | Cyanidation. | | |
| | | Gold. | Silver. | Gold. | Silver. | |
| | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Fine ozs.* | *Fine ozs.* | |
| Churchill | [a] 19,418 | 106.88 | 164 | 4,945.00 | 371,289 | $301,302 |
| Clark | [b] 2,074 | 788.84 | 817 | [c] 230.36 | [c] 4,159 | 23,706 |
| Douglas | 27 | 24.83 | 19 | ..... | ..... | 523 |
| Elko | 9,850 | 1,004.67 | 1,115 | [d] 3,079.71 | [d] 23,457 | 97,455 |
| Esmeralda | [e] 571,862 | 121,135.16 | 22,163 | 409,008.84 | 60,101 | 10,816,603 |
| Eureka | 15,403 | 37.71 | 38 | 4,705.24 | 1,459 | 98,839 |
| Humboldt | [f] 7,407 | 45,199.91 | 72,845 | [g] 1,272.60 | [g] 15,653 | 1,007,576 |
| Lander | [h] 887 | 333.08 | 720 | [i] 356.87 | [i] 38,897 | 35,260 |
| Lincoln | 220 | .38 | 281 | 28.57 | 6 | 750 |
| Lyon | [j] 16,471 | 5,114.06 | 5,181 | 25.00 | 50 | 109,006 |
| Mineral | [k] 7,422 | 3,484.99 | 25,731 | [l] 800.12 | [l] 14,987 | 110,162 |
| Nye | [m] 475,950 | 38,598.68 | 18,288 | [n] 82,669.86 | [n] 6,375,380 | 5,895,487 |
| Ormsby | 1,635 | [o] 873.55 | [o] 7,458 | ..... | ..... | 22,010 |
| Storey | [p] 89,799 | 4,760.19 | 10,603 | [q] 6,131.17 | [q] 89,798 | 278,357 |
| Washoe | [r] 3,307 | 3,118.30 | 3,020 | [s] 10.24 | [s] 2,023 | 67,346 |
| White Pine | [t] 853 | 407.52 | 190 | ..... | ..... | 8,525 |
| Total | [u] 1,222,585 | [v]224,988.75 | [v] 168,633 | [w]504,263.58 | [w] 6,997,259 | [x] 18,872,907 |

[a] Yielded in addition to cyanide bullion, 164 tons of sulphide concentrate containing gold and silver.
[b] Yielded 1 ton of heavy oxide and sulphide concentrate.
[c] Includes bullion recovered from 445 tons of old tailings.
[d] Includes bullion recovered from 16,830 tons of old tailings.
[e] Yielded 21,373 tons of sulphide iron-copper concentrate, from which some gold and silver bullion was extracted by cyanidation.
[f] Yielded 294 tons mixed heavy oxide and sulphide concentrate, containing gold and silver with a little copper and lead.
[g] Includes bullion from 1,135 tons of old tailings.
[h] Yielded 9 tons of lead sulphide concentrate, carrying gold and silver.
[i] Includes bullion from 12,000 tons of old tailings.
[j] Includes 175 tons of old tailings.
[k] Yielded 17 tons of mixed heavy oxide and sulphide, gold, silver, and lead concentrates.
[l] Includes bullion from 1,710 tons of old tailings.
[m] Yielded 2,808 tons of concentrate, carrying silver sulphides, also containing values in gold, and 9 tons of gold, silver, copper, and lead concentrates.
[n] Includes bullion from 14,164 tons of old tailings.
[o] Includes bullion from 80 tons of old tailings.
[p] Yielded 1,287 tons of sulphide concentrate, carrying gold and silver.
[q] Includes bullion from 1,275 tons of old tailings.
[r] Yielded 60 tons of gold and silver concentrate, one lot containing a little copper and a trace of lead.
[s] Includes bullion from 600 tons of old tailings.
[t] Yielded 4 tons of lead sulphide concentrate, carrying small values in silver and copper.
[u] Crude ore only; does not include old tailings, which aggregated 52,242 tons.
[v] Includes 15.10 ounces of gold and 291 ounces of silver, valued at $466, extracted from 80 tons of old tailings.
[w] Includes 4,047.56 ounces of gold and 81,544 ounces of silver, valued at $126,889, recovered from 52,162 tons of old tailings.
[x] Total value of crude ore and old tailings treated by amalgamation and cyanidation.

At mills equipped for concentration alone 2,751,552 tons of ore were treated, yielding 269,709 tons of concentrate, containing 81,097.61 ounces, or 9.21 per cent of the total gold; 2,581,229 ounces, or 19.58 per cent of the total silver; 65,279,799 pounds, or 96.89 per cent of the total copper; 692,180 pounds, or 21.21 per cent of the total lead; and 210,257 pounds, or 5.93 per cent of the total zinc, valued at $11,247,595, or an average value of $41.70 per ton. Copper concentrate comprised nearly nine-tenths of the tonnage of the total concentrate produced, or 242,099 tons, which gave an average recovery assay per ton of $1.76 in gold, 0.40 ounce of silver, and 13.48 per cent of copper, giving a total average value of $35.67 per ton. The ore from which the copper concentrate was saved aggregated 2,745,524 tons, and gave an average recovery assay of 16 cents in gold, 0.04

ounce of silver, and 1.19 per cent of copper, or a total average value of $3.15 per ton. Dry or siliceous concentrate, containing mostly iron sulphides with included auriferous minerals—possibly famatinite and bismuthinite—was produced from the ores treated at the Goldfield mills. These concentrates, including those produced at Tonopah, aggregating 25,970 tons, were recovered from 771,436 tons of ore and contained an average of $47.72 in gold, 92 ounces of silver, and 0.02 per cent of copper, averaging in total value $96.54 per ton.

*Mine production of gold, silver, copper, lead, and zinc from Nevada concentrates in 1911, by counties.*

| County. | Ore to concentrating mills. | Concentrates produced. | | | | | | Total value of concentrates. |
|---|---|---|---|---|---|---|---|---|
| | | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Churchill | | 164 | 880.00 | 82,436 | | | | $61,882 |
| Clark | 2,317 | 730 | 15.89 | 12,957 | | 458,216 | 210,257 | 39,800 |
| Esmeralda | 69 | 21,396 | 16,642.16 | 47,713 | 15,794 | 45,130 | | 373,317 |
| Humboldt | | 294 | 4,196.15 | 12,493 | 60 | 567 | | 93,395 |
| Lander | 1,938 | 219 | 343.77 | 35,941 | 348 | 6,038 | | 26,470 |
| Lincoln | 912 | 393 | 47.54 | 4,090 | 354 | 106,146 | | 7,972 |
| Mineral | 741 | 198 | 88.37 | 36,242 | | 47,318 | | 23,164 |
| Nye | | 2,817 | 15,230.46 | 1,939,383 | 231 | 1,337 | | 1,342,604 |
| Storey | | 1,287 | 22,914.50 | 307,188 | | | | 636,495 |
| Washoe | 51 | 77 | 74.06 | 3,201 | 174 | 27,004 | | 4,464 |
| White Pine | 2,745,524 | 242,134 | 20,664.71 | 99,585 | 65,262,838 | 424 | | 8,637,832 |
| Total | 2,751,552 | 269,709 | 81,097.61 | 2,581,229 | 65,279,799 | 692,180 | 210,257 | 11,247,595 |
| Subdivision by kinds of concentrates: | | | | | | | | |
| Dry or siliceous | | 26,213 | 60,276.73 | 2,428,099 | 12,575 | 5,279 | | 2,534,732 |
| Copper | | 242,099 | 20,625.91 | 97,232 | 65,262,796 | | | 8,635,757 |
| Lead | | 921 | 157.21 | 52,459 | 767 | 525,121 | | 54,779 |
| Zinc | | 446 | | 2,887 | | 139,003 | 210,257 | 19,770 |
| Copper-lead | | 30 | 37.76 | 552 | 3,661 | 22,777 | | 2,557 |

*Kinds of concentrates and average metallic content of milling ore and concentrates produced in Nevada in 1911.*

| Kinds of concentrates and source of production. | Milling ore. | Concentrates. | Average metallic content per ton. | | | | | | | | | | Average value per ton. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gold. | | Silver. | | Copper. | | Lead. | | Zinc. | | | |
| | | | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. |
| | *Short tons.* | *Short tons.* | | | *Fine ounces.* | *Fine ounces.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | | |
| Dry or siliceous: | | | | | | | | | | | | | | |
| Gold and silver mills | 771,436 | 25,970 | $1.61 | $47.72 | 3.10 | 92.00 | ..... | 0.02 | ..... | ..... | ..... | ..... | $3.25 | $96.54 |
| Concentration mills | 1,963 | 243 | 3.42 | 27.69 | 19.81 | 160.03 | 0.01 | .07 | 0.12 | 0.97 | ..... | ..... | 14.06 | 113.55 |
| Copper: | | | | | | | | | | | | | | |
| Concentration mills | 2,745,524 | 242,099 | .16 | 1.76 | .04 | .40 | 1.19 | 13.48 | ..... | ..... | ..... | ..... | 3.15 | 35.67 |
| Lead: | | | | | | | | | | | | | | |
| Gold and silver mills | 1,898 | 26 | 1.16 | 84.81 | 1.17 | 85.31 | .01 | .53 | .12 | 9.02 | ..... | ..... | 1.91 | 139.46 |
| Concentration mills | 4,064 | 895 | .26 | 1.17 | 12.36 | 56.13 | ..... | .03 | 6.40 | 29.07 | ..... | ..... | 12.59 | 57.15 |
| Zinc: | | | | | | | | | | | | | | |
| Concentration mills | 2,317 | 446 | ..... | ..... | 1.25 | 6.47 | ..... | ..... | 3.00 | 15.58 | 4.54 | 23.57 | 8.53 | 44.33 |
| Copper-lead: | | | | | | | | | | | | | | |
| Gold and silver mills | 90 | 30 | 8.68 | 26.03 | 6.13 | 18.40 | 2.03 | 6.10 | 12.65 | 37.96 | ..... | ..... | 28.41 | 85.23 |

There were 109,119 tons of crude smelting ores treated. The larger part was shipped to different smelters in Utah and California, and about one-third of the tonnage was smelted in Nevada at McGill. The ore contained 59,569.92 ounces, or 6.77 per cent of the total gold; 3,432,407 ounces, or 26.03 per cent of the total silver; 2,094,393 pounds, or 3.11 per cent of the total copper; 2,571,477 pounds, or 78.79 per cent of the total lead; and 3,337,775 pounds, or 94.07 per cent of the total zinc—valued in all at $3,618,364, or an average value of $33.16 per ton. In 1910 the total value was $4,501,062 and the average value per ton was $43.05. About two-thirds of the tonnage smelted in 1911 was dry or siliceous ores, mostly the latter, aggregating 67,584 tons, which contained an average of $17.59 in gold, and 47.85 ounces of silver per ton, 0.03 per cent of copper, and 0.07 per cent of lead, and an average value of $43.09 per ton. Copper ores aggregating 32,789 tons carried an average of 76 cents in gold, and 0.42 ounce of silver per ton, and 3.08 per cent of copper, and were valued at $8.68 per ton. Lead ores aggregating 3,180 tons averaged $5.08 in gold, and 45.80 ounces of silver per ton, and 0.13 per cent of copper, and 24.07 per cent of lead, and in value $51.33 per ton. Zinc ores aggregating 3,013 tons contained a trace of gold, and 3.06 ounces of silver per ton, and 0.01 per cent of copper, 3 per cent of lead, and 32.36 per cent of zinc, and were valued at $41.24 per ton. Copper-lead ores aggregated 216 tons, averaging $4.55 in gold, and 45.49 ounces of silver per ton, and 5.47 per cent of copper, and 16.99 per cent of lead, and were valued at $57.65 per ton. Lead-zinc ores aggregated 2,337 tons, containing an average of 12 cents in gold, and 8.52 ounces of silver per ton, and 14.84 per cent of lead, and 29.69 per cent of zinc, and were valued at $51.85 per ton. The Steptoe copper smelter, at McGill, Nev., was the only smelting plant in operation, treating concentrate and crude ore from the Nevada Consolidated mines in 1911. The copper smelter near Empire, in Ormsby County, was not completed, it is said for the lack of funds, but the copper plant[1] in Mineral County, near Wabuska, was ready to fire up at the end of 1911.

[1] Commenced to receive ore in November and started operations in January, 1912.

*Mine production of gold, silver, copper, lead, and zinc from Nevada crude ore shipped to smelters in 1911, by counties.*

| County. | Crude ore to smelters. | | | | | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | *Fine ounces* | *Fine ounces* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Churchill | 45 | 66.14 | 2,177 | ..... | 117 | ..... | $2,526 |
| Clark | 6,299 | 194.31 | 37,710 | 185,915 | 1,171,355 | 3,337,775 | 290,206 |
| Douglas | 11 | .13 | 107 | ..... | 5,404 | ..... | 303 |
| Elko | 266 | 338.65 | 5,804 | 16,369 | 94,276 | ..... | 16,364 |
| Esmeralda | 2,822 | 3,943.64 | 54,975 | 64,683 | 38,288 | ..... | 120,467 |
| Eureka | 231 | 204.55 | 13,746 | 2,617 | 61,136 | ..... | 14,591 |
| Humboldt | 1,111 | 8,268.42 | 153,705 | 8,593 | 71,283 | ..... | 256,669 |
| Lander | 1,345 | 1,983.77 | 85,055 | 5,710 | 60,104 | ..... | 89,507 |
| Lincoln | 23,621 | 290.29 | 170,397 | 17,028 | 349,344 | ..... | 114,162 |
| Lyon | 99 | 83.60 | 2,595 | 2,727 | ..... | ..... | 3,445 |
| Mineral | 956 | 322.53 | 88,577 | 12,868 | 137,344 | ..... | 61,402 |
| Nye | 35,376 | 29,855.17 | 2,581,369 | 2,033 | 1,471 | ..... | 1,985,607 |
| Ormsby | 12 | 18.24 | 25 | 1,526 | ..... | ..... | 580 |
| Storey | 4,820 | 13,473.40 | 210,417 | ..... | ..... | ..... | 390,041 |
| Washoe | 25 | 4.28 | 2,838 | 1,801 | 9,125 | ..... | 2,229 |
| White Pine | 32,080 | 522.80 | 22,910 | 1,772,523 | 572,230 | ..... | 270,265 |
| Total | 109,119 | 59,569.92 | 3,432,407 | 2,094,393 | 2,571,477 | 3,337,775 | 3,618,364 |
| Subdivision by kinds of ore: | | | | | | | |
| Dry or siliceous | 67,584 | 57,515.56 | 3,234,107 | 41,932 | 93,019 | ..... | 2,912,456 |
| Copper | 32,789 | 1,210.70 | 13,705 | 2,019,998 | ..... | ..... | 284,791 |
| Lead | 3,180 | 781.79 | 145,634 | 8,055 | 1,530,591 | ..... | 163,230 |
| Zinc | 3,013 | .27 | 9,216 | 764 | 180,910 | 1,949,898 | 124,270 |
| Copper-lead | 216 | 47.60 | 9,826 | 23,644 | 73,423 | ..... | 12,452 |
| Lead-zinc | 2,337 | 14.00 | 19,919 | ..... | 693,534 | 1,387,877 | 121,165 |

*Mine production of crude ore, by kinds, and average metallic content of each kind shipped to smelters in Nevada in 1911.*

| Kind of crude ore. | Quantity. | Average metallic content per ton. | | | | | Average value per ton. |
|---|---|---|---|---|---|---|---|
| | | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | *Value.* | *Fine ounces.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Dry or siliceous | 67,584 | $17.59 | 47.85 | 0.03 | 0.07 | ..... | $43.09 |
| Copper | 32,789 | .76 | .42 | 3.08 | ..... | ..... | 8.68 |
| Lead | 3,180 | 5.08 | 45.80 | .13 | 24.07 | ..... | 51.33 |
| Zinc | 3,013 | ..... | 3.06 | .01 | 3.00 | 32.36 | 41.24 |
| Copper-lead | 216 | 4.55 | 45.49 | 5.47 | 16.99 | ..... | 57.65 |
| Lead-zinc | 2,337 | .12 | 8.52 | ..... | 14.84 | 29.69 | 51.85 |

## MINING INDUSTRY IN NEVADA IN 1911.

The mining industry of Nevada in 1911 prospered and continued to show greatly improved conditions in the amount of capital expended for development and equipment of legitimate mining enterprises. There was a tendency throughout the year for larger companies to absorb smaller ones or to take over properties strategically situated. This was evident at Pioche and Tonopah. Twelve new mills were under construction in the State and many were being remodeled. Deep prospecting was provided for at Goldfield in the formation of the Goldfield Deep Mines Co. In the outlying districts noteworthy progress was made at the Nevada Hills and Nevada Wonder properties in Churchill County and at the Mason Valley enterprise in Lyon County. Jarbidge, in Elko County, and Seven Troughs, in Humboldt County, received attention from prospectors and investors, but no important

developments took place. Another most important feature of the year's record is the great advance made in the treatment of the Tonopah ores, an increased recovery of values being now made at a reduced cost of milling. The cost of milling of gold ores has also been very largely reduced at Goldfield, Round Mountain, and Blair, demonstrating that ores regarded five years ago as nonpaying can now be profitably treated. It is estimated that no less than $12,478,277 was distributed in dividends by 11 Nevada mining companies in 1911. Many of the larger mining companies in Nevada have found it necessary to change the periods for their reports from the fiscal year to the calendar year, and make a number of modifications and changes in the accounts in order to comply with the act of Congress approved August 5, 1909, and popularly known as the Federal corporation income tax law.

*Mine production of gold, silver, copper, lead, and zinc in Nevada in 1911, by counties.*

| County. | Gold. | | | | Silver. | |
|---|---|---|---|---|---|---|
| | Placers. | | Deep mines. | | | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | *Fine ozs.* | | *Fine ozs.* | | *Fine ozs.* | |
| Churchill | | | 5,998.02 | $123,990 | 456,066 | $241,715 |
| Clark | | | 1,229.40 | 25,414 | 55,643 | 29,491 |
| Douglas | 56.70 | $1,172 | 24.96 | 516 | 137 | 73 |
| Elko | 57.32 | 1,185 | 4,423.03 | 91,432 | 30,417 | 16,120 |
| Esmeralda | 2.57 | 53 | 541,729.80 | 11,198,549 | 184,953 | 98,026 |
| Eureka | 443.12 | 9,160 | 4,947.50 | 102,274 | 15,273 | 8,095 |
| Humboldt | 255.42 | 5,280 | 58,941.75 | 1,218,434 | 255,367 | 135,345 |
| Lander | 343.07 | 7,092 | 3,017.50 | 62,377 | 160,680 | 85,161 |
| Lincoln | | | 366.78 | 7,582 | 174,774 | 92,630 |
| Lyon | 24.62 | 509 | 5,222.66 | 107,962 | 7,839 | 4,155 |
| Mineral | 324.06 | 6,699 | 4,696.01 | 97,075 | 165,808 | 87,878 |
| Nye | 8,631.55 | 178,430 | 166,354.17 | 3,438,846 | 10,918,263 | 5,786,679 |
| Ormsby | 42.62 | 881 | 891.79 | 18,435 | 7,608 | 4,032 |
| Storey | | | 47,279.26 | 977,349 | 618,006 | 327,543 |
| Washoe | | | 3,206.88 | 66,292 | 11,082 | 5,873 |
| White Pine | | | 21,595.03 | 446,409 | 122,685 | 65,023 |
| Total | 10,181.05 | 210,461 | 869,924.53 | 17,982,936 | 13,184,601 | 6,987,839 |

| County. | Copper. | | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | *Pounds.* | | |
| Churchill | | | 117 | $5 | | | $365,710 |
| Clark | 185,915 | $23,239 | 1,629,571 | 73,331 | 3,548,032 | $202,238 | 353,713 |
| Douglas | | | 5,404 | 243 | | | 2,004 |
| Elko | 16,369 | 2,046 | 94,276 | 4,243 | | | 115,026 |
| Esmeralda | 80,477 | 10,060 | 83,418 | 3,754 | | | 11,310,442 |
| Eureka | 2,617 | 327 | 61,136 | 2,751 | | | 122,607 |
| Humboldt | 11,979 | 1,497 | 71,850 | 3,233 | | | 1,363,789 |
| Lander | 6,058 | 757 | 66,142 | 2,976 | | | 158,363 |
| Lincoln | 17,382 | 2,173 | 455,490 | 20,497 | | | 122,882 |
| Lyon | 2,727 | 341 | | | | | 112,967 |
| Mineral | 12,868 | 1,609 | 184,662 | 8,310 | | | 201,571 |
| Nye | 2,264 | 283 | 2,808 | 127 | | | 9,404,365 |
| Ormsby | 1,526 | 191 | | | | | 23,539 |
| Storey | | | | | | | 1,304,892 |
| Washoe | 1,975 | 247 | 36,129 | 1,626 | | | 74,038 |
| White Pine | 67,035,361 | 8,379,420 | 572,654 | 25,769 | | | 8,916,621 |
| Total | 67,377,518 | 8,422,190 | 3,263,657 | 146,865 | 3,548,032 | 202,238 | 33,952,529 |

*Tonnage of ore sold or treated, number of deep mines producing, and average value per ton of ores in Nevada in 1910 and 1911, by counties.*

| County. | Ore sold or treated. | | Number of deep mines producing. | | Average value per ton.[a] | | Average value per ton in gold and silver.[a] | |
|---|---|---|---|---|---|---|---|---|
| | 1911 | Increase (+) or decrease (−). | 1910 | 1911 | 1910 | 1911 | 1910 | 1911 |
| | *Short tons.* | *Short tons.* | | | | | | |
| Churchill | 19,463 | + 18,299 | 15 | 14 | $113.86 | $18.79 | $112.40 | $18.79 |
| Clark | 11,135 | − 22,505 | 36 | 35 | 13.88 | 31.76 | 7.01 | 4.93 |
| Douglas | 38 | + 15 | 3 | 3 | 21.69 | 21.74 | 21.69 | 15.34 |
| Elko | 26,946 | + 22,486 | 35 | 27 | 14.14 | 4.22 | 11.87 | 3.99 |
| Esmeralda | 574,753 | + 50,771 | 79 | 64 | 23.14 | 19.68 | 23.09 | 19.65 |
| Eureka | 15,634 | + 3,657 | 8 | 13 | 10.48 | 7.25 | 8.00 | 7.06 |
| Humboldt | 9,665 | + 3,017 | 71 | 95 | 242.67 | 140.55 | 241.83 | 140.06 |
| Lander | 16,170 | + 3,686 | 16 | 20 | 6.70 | 9.35 | 6.29 | 9.12 |
| Lincoln | 25,643 | + 21,333 | 18 | 14 | 24.70 | 4.79 | 14.93 | 3.91 |
| Lyon | 16,745 | + 5,628 | 28 | 51 | 11.11 | 6.71 | 11.11 | 6.69 |
| Mineral | 10,829 | − 7,914 | 68 | 56 | 26.21 | 17.98 | 24.22 | 17.07 |
| Nye | 525,489 | + 913 | 95 | 99 | 17.58 | 17.55 | 17.56 | 17.55 |
| Ormsby | 1,727 | + 1,726 | 1 | 5 | 83.00 | 13.08 | 83.00 | 12.97 |
| Storey | 95,894 | − 12,698 | 26 | 34 | 6.23 | 13.61 | 6.23 | 13.61 |
| Washoe | 3,983 | + 311 | 17 | 34 | 13.18 | 18.59 | 12.39 | 18.12 |
| White Pine | 2,778,607 | + 388,221 | 24 | 25 | 3.64 | 3.21 | .24 | .18 |
| Total | 4,132,721 | + 476,946 | 540 | 589 | 9.30 | 8.16 | 6.96 | 6.04 |

[a] Value per ton, placer product excluded.

*Number of mines producing, classified by chief products, in Nevada in 1911, by counties.*

| County. | Placer mines. | | | Deep mines. | | | | | | | | | | | | Total mines producing. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hydraulic, dry, and sluicing. | Dredging. | Drift. | Gold. | Silver. | Copper. | Zinc. | Gold, silver. | Gold, silver, copper. | Gold, silver, copper, lead. | Gold, silver, copper, lead, zinc. | Gold, silver, lead. | Silver, copper. | Silver, lead. | Silver, lead, zinc. | |
| Churchill | .... | .... | .... | .... | .... | .... | .... | 13 | .... | .... | .... | 1 | .... | .... | .... | 14 |
| Clark | .... | .... | .... | .... | .... | .... | .... | [a]3 | 15 | 2 | 2 | [b]2 | 3 | 1 | 3 | [c]4 | 35 |
| Douglas | 3 | 1 | .... | .... | .... | .... | .... | 2 | .... | .... | .... | 1 | .... | .... | .... | 7 |
| Elko | 3 | .... | .... | .... | .... | .... | .... | 20 | 2 | 3 | .... | 1 | .... | [d]1 | .... | 30 |
| Esmeralda | 1 | .... | .... | 6 | 2 | 1 | .... | 33 | 6 | 4 | .... | 10 | 1 | [d]1 | .... | 65 |
| Eureka | 6 | .... | .... | .... | .... | .... | .... | 4 | .... | 3 | .... | 4 | .... | [d]2 | .... | 19 |
| Humboldt | 7 | 1 | .... | 1 | 1 | .... | .... | 67 | 1 | 6 | .... | 16 | 3 | .... | .... | 103 |
| Lander | 11 | .... | .... | .... | 1 | .... | .... | 5 | 1 | 9 | .... | 3 | 1 | .... | .... | 31 |
| Lincoln | .... | .... | .... | .... | .... | .... | .... | 6 | .... | 7 | .... | 1 | .... | .... | .... | 14 |
| Lyon | 1 | .... | .... | 1 | .... | .... | .... | 49 | 1 | .... | .... | .... | .... | .... | .... | 52 |
| Mineral | 7 | .... | .... | 2 | .... | .... | .... | 35 | 3 | 5 | .... | 8 | 1 | 2 | .... | 63 |
| Nye | 21 | .... | 9 | 2 | .... | .... | .... | 93 | 1 | 2 | .... | [e]1 | .... | .... | .... | 129 |
| Ormsby | 1 | .... | .... | .... | .... | .... | .... | 4 | 1 | .... | .... | .... | .... | .... | .... | 6 |
| Storey | .... | .... | .... | .... | .... | .... | .... | 34 | .... | .... | .... | .... | .... | .... | .... | 34 |
| Washoe | .... | .... | .... | .... | .... | .... | .... | 30 | 2 | 2 | .... | .... | .... | .... | .... | 34 |
| White Pine | .... | .... | .... | .... | 1 | .... | .... | 5 | 1 | 10 | .... | 3 | 1 | [f]4 | .... | 25 |
| Total | 61 | 2 | 9 | 12 | 5 | 1 | 3 | 415 | 21 | 53 | 2 | 52 | 8 | 13 | 4 | 661 |

[a] One reported lead.
[b] One reported no lead.
[c] One reported also gold.
[d] One reported also copper.
[e] One reported no silver.
[f] One reported also copper.

## REVIEW BY COUNTIES.

### CHURCHILL COUNTY.

In 1911 in Churchill County 14 deep mines produced 19,463 tons of ore, which is 18,299 tons more than was produced by 15 mines in 1910. The larger part, or 19,418 tons, was treated at gold and silver mills by amalgamation and cyanide processes, by which gold and silver bullion valued at $301,302 was extracted from the ore. At one amalgamation mill concentrates containing gold and silver were saved. The bulk of the bullion was recovered by the cyanidation process. Crude ore shipped directly to the smelters contained a small quantity of lead and good values in gold and silver. The total output in 1911 averaged only $18.79 per ton, owing to the enlarged tonnage of ore, which was run of mine rather than the selected ores of several properties. In 1910 the county output of ore aggregated 1,164 tons, with an average value of $113.86 per ton.

*Fairview district.*—The yield of ore produced from 6 deep mines aggregated 9,597 tons, containing $70,820 in gold, 283,411 ounces of silver, and 117 pounds of lead, valued in all at $221,033, or an average value of $23.03 per ton. Nearly all of the ore, or 9,580 tons, produced gold and silver bullion extracted by the amalgamation and cyanidation processes. Some concentrate was saved at one of the mills. Only 17 tons of ore of shipping grade were hauled by wagon 42 miles to Fallon, the shipping point on the Southern Pacific Railroad. This ore contained gold, silver, and a small quantity of lead.

The new mill of the Nevada Hills [1] started operations on September 10, 1911, and to the end of the year had treated 10,948 tons of ore, which contained gold and silver valued at $293,945.37, or an average value of $26.83 per ton. The tailing loss was $3 per ton, giving an average saving of 88.8 per cent. Milling expenses were $4.88 per ton of ore treated. The total operating expense was $18.13 per ton of ore mined. In addition to the ore milled 8 tons, averaging $262.19 per ton, were shipped directly to the smelter. The Nevada Hills mine was the largest producer of ore in the county, most of it oxidized, which was treated in the 20-stamp mill equipped for cyanidation and concentration.

The Cyclone property produced under lease gold and silver iron sulphide ore carrying a trace of lead. The property is opened by a vertical shaft 155 feet deep. The ores of the district occur in veins.[2]

*Jessup district.*—A small quantity of ore was produced from the Mohawk and the Gold King properties. The latter is reported to have a shaft 150 feet deep and the former a vertical shaft 200 feet deep with about 500 feet of drifts. The district is 35 miles south of Lovelocks.

*Wonder district.*—The Nevada Wonder [3] mine yielded during the last two months of its fiscal year 3,444 tons of ore, which contained 1,154 ounces of gold and 76,848 ounces of silver, valued in all at $64,183.28, or an average of $18.64 per ton. This ore was treated in the company's mill, which was started August 1, 1911. An average of 92.6 per cent extraction of the values was made by the cyanide process. The mill was built for a daily capacity of 100 tons,

[1] Annual Report for year ending Mar. 31, 1912.
[2] Hill, J. M., Mining districts of the United States; Bull. U. S. Geol. Survey No. 507, p. 200. [In press.]
[3] Annual Report for year ending Sept. 30, 1911.

but was found to treat 125 tons of ore per day. The average cost of milling for two months was $4.07 per ton. Metal loss in mill and tailing was $1.22 per ton, and mining cost $4.08 per ton. The ore is crushed in cyanide solution and the all-sliming process was used. Some concentrate was produced as an experiment, but it was reported that concentration is not necessary, as cyanidation makes a satisfactory saving. The property is opened by a vertical shaft 500 feet deep, with 7,881 feet of drifts and crosscuts. The ore mined is partly oxidized and partly sulphide with a siliceous gangue. The ore occurs in veins.[1]

## CLARK COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Clark County, Nev., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 10,603.36 | $219,191 | 1,229.40 | $25,414 | −9,373.96 | −$193,777 |
| Silver.....do.... | 30,650 | 16,551 | 55,643 | 29,491 | + 24,993 | + 12,940 |
| Copper.....pounds. | 216,773 | 27,530 | 185,915 | 23,239 | − 30,858 | − 4,291 |
| Lead.....do.... | 1,309,684 | 57,626 | 1,629,571 | 73,331 | + 319,887 | + 15,705 |
| Zinc.....do.... | 2,707,071 | 146,182 | 3,548,032 | 202,238 | + 840,961 | + 56,056 |
| Total..... | ..... | 467,080 | ..... | 353,713 | ..... | − 113,367 |

The tonnage of ore mined by 35 producers in 1910 was 33,640 tons, against 11,135 tons, the yield of 36 producers, in 1911, but the total average value increased from $13.88 to $31.76 per ton. The gold and silver value in this ore decreased from $7.01 per ton in 1910 to $4.93 in 1911. Much of the ore was of shipping grade, of which 6,299 tons yielded gold, silver, copper, lead, and zinc valued at $290,206, or an average value of $46.07 per ton. At concentration plants 2,317 tons of ore were treated, yielding a lead-zinc concentrate carrying gold and silver. At gold and silver mills using amalgamation and cyanidation processes, 2,074 tons of ore were treated, which, with 445 tons of old tailings, yielded $23,706 in gold and silver bullion, the larger part of which was extracted by amalgamation.

*Crescent district.*—Sixty-seven tons of ore were produced in 1911, yielding $416 in gold, 2,636 ounces of silver, 101 pounds of copper, and 4,652 pounds of lead, valued in all at $2,034, or an average value of $30.36 per ton. Most of the ore was treated at amalgamation mills, yielding gold and silver bullion, and the remainder, 23 tons, containing gold, silver, and lead, was shipped to a smelter. The Golden Calf property was the most important producer of quartz ore, mined from trenches, open cuts, and shallow shafts. This was treated in a 1-stamp Nissen mill with a capacity of about 4 tons per day, and gold amalgam and concentrates were shipped. The mill is new and was operated during the latter part of 1911. At the Treasure Trove property lead sulphide ore was mined, carrying important silver values with some gold. The mine is opened by an incline shaft 250 feet deep. The shipping point of these mines is Nipton, Cal., which is 6 miles west of the district.

[1] Hill, J. M., loc cit.

*Eldorado Canyon district.*—Ores aggregating 541 tons were produced from 6 properties in 1911, and yielded $2,595 in gold and 3,799 ounces of silver, valued in all at $4,611, or an average value of $8.52 per ton. The bulk of the ore, or 535 tons, was treated at amalgamation and cyanide plants, yielding gold and silver bullion, which contained $2,538 in gold and 3,607 ounces of silver. Only 6 tons of gold and silver ore were shipped to the smelters. A test lot of gold and silver bullion was taken out in development work from the Rand property, which is opened by a vertical shaft 400 feet deep. The Queen mine has a small testing plant equipped for amalgamation and cyanidation, which was operated during the early part and the latter part of the year on ores taken from different parts of the mine, but chiefly from the surface. The property is opened by a tunnel 130 feet long. Nelson is the main supply point of the district and is 24 miles northeast of Searchlight. The ores occur in veins [1] in pre-Cambrian granite and gneiss cut by acidic intrusives and capped by Tertiary volcanics.

*Searchlight district.*—From 10 properties there was reported a production of 1,850 tons of ore, yielding $19,979 in gold, 2,136 ounces of silver, 12,095 pounds of copper, and 7,659 pounds of lead, valued in all at $22,968, or an average value of $12.42 per ton. Included in this output was the bullion recovered from 445 tons of old tailings. The larger part of the ore, or 1,295 tons, was treated at amalgamation mills, yielding bullion containing 873.08 ounces of gold and 1,358 ounces of silver. The remainder of the output was contained in 110 tons of ore of shipping grade. The principal production was made from the Golden Treasure and other properties of the Quartette Mining Co., and was treated in a 40-stamp mill by the amalgamation process. The closing of this property decreased the production of the district. Operations are now in the hands of lessees. A small shipment of ore was made directly to the smelter. The property is opened by an incline shaft 1,267 feet deep. The total workings aggregate about 5½ miles. The ore is mostly oxidized and has a siliceous gangue. It is reported that no change is found in the character of the ore to a vertical depth of over 1,000 feet. The Chief of the Hills property was operated by lessees who worked the ore at an amalgamation mill on the Cyrus Noble property. Some old tailings were also re-treated and some gold and silver ore was shipped directly to the smelter. A small production of gold and silver bullion was made from the Searchlight Parallel mine, which is opened by a shaft 492 feet deep. The ores occur in veins [2] in pre-Cambrian complex cut by quartz monzonite and capped by Tertiary volcanics.

*Sunset and Yellowpine districts.*—Seventeen deep mines reported output from this district in 1911, amounting to 8,677 tons of ore carrying $2,424 in gold, 47,072 ounces of silver, 173,719 pounds of copper, 1,617,228 pounds of lead, and 3,548,032 pounds of zinc, valued in all at $324,100, or an average value of $37.35 per ton. Most of the ore was of shipping grade, aggregating 6,160 tons, containing 96.37 ounces of gold, 34,114 ounces of silver, 173,719 pounds of copper, 1,159,012 pounds of lead, and 3,337,775 pounds of zinc. All of the copper output and the bulk of the zinc was contained in the crude shipping ore. Part of the output given above was milled at one plant from ore mined near Lyons, 15 miles southeast of Jean,

[1] Hill, J. M., loc. cit. [2] Hill, J. M., op. cit., p. 202.

and yielded concentrate containing gold, silver, lead, and zinc. The Rover group of the Yellowpine Mining Co. yielded the largest quantity of zinc ore, about half of which was shipped directly to the smelters, the lower grade being treated at the new concentration mill on the property. The crude ore carries values largely in zinc and silver and a small quantity of gold, and the concentrates carry lead and zinc with important silver values and a trace of gold. All of the ores are carbonates with a somewhat basic gangue. The mine is opened by an incline shaft 500 feet deep. The property is equipped with a 75-ton concentration mill using rolls, jigs, and tables. The second important producer was the Potosi mine, which yielded carbonate zinc ore carrying lead and silver. Copper ores of shipping grade were produced at the Ninety-nine mine. Lessees worked on the Milford and Addison groups, producing in a small way carbonate lead-zinc ore carrying a small amount of silver. The shipping points of this district are Arden, Jean, and Roach.

### DOUGLAS COUNTY.

The larger part of 38 tons of ore, produced from 3 mines, was treated at an amalgamation mill, and the remainder, containing lead, was shipped crude to the smelter. The same number of producers operated in 1910. The total average value of the ore increased from $21.69 per ton in 1910 to $21.74 in 1911, but the gold and silver value decreased from $21.69 to $15.34 per ton. The bullion yield from placers was valued at $1,172 for the gold and contained 11 ounces of silver.

*Gardnerville district.*—Three deep mines and 3 placers produced bullion and ore valued at $1,900. The ore, part of which was shipped crude, contained lead, silver, and a small quantity of gold. The remainder was treated in an amalgamation mill and yielded gold bullion. The placers yielded $1,070 in gold and 8 ounces of silver. Part of the output was made from the Pine Nut property in cleaning up the mill. The mine has been opened to a depth of 100 feet by a vertical shaft and has 300 feet of drifts. The Buckeye placers produced, during prospect work in 1911, gold averaging in fineness 0.880. The placers lie north of Mount Siegel, at an altitude of 7,100 feet at the head of Buckeye Creek, 16 miles east of Minden, a station on the branch of the Virginia & Truckee Railroad extending south of Carson City.

### ELKO COUNTY.

*Mine production of gold, silver, copper, and lead in Elko County, Nev., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 2,102.72 | $43,467 | 4,480.35 | $92,617 | +2,377.63 | +$49,150 |
| Silver.....do.... | 18,658 | 10,076 | 30,417 | 16,120 | + 11,759 | + 6,044 |
| Copper.....pounds.. | 9,768 | 1,240 | 16,369 | 2,046 | + 6,601 | + 806 |
| Lead.....do.... | 201,631 | 8,872 | 94,276 | 4,243 | − 107,355 | − 4,629 |
| Total..... | ..... | 63,655 | ..... | 115,026 | ..... | + 51,371 |

The operators of 27 properties in Elko County mined 26,946 tons of ore, which is 22,486 tons more than was mined by 35 producers in 1910. The total average value of this tonnage decreased from $14.14 in 1910 to $4.22 per ton in 1911, and the gold and silver value of this ore from $11.87 to $3.99 per ton. At gold and silver mills using amalgamation and cyanide processes, 9,850 tons of ore were treated, which, with 16,830 tons of old tailings, yielded gold and silver bullion valued at $97,455. Crude smelting ores shipped to smelters aggregated 266 tons, containing $7,000 in gold, 5,804 ounces of silver, 16,369 pounds of copper, and 94,276 pounds of lead, valued in all at $16,364, or an average of $61.52 per ton. The bullion recovered from placer operations contained $1,185 in gold and 41 ounces of silver.

*Aura and Centennial districts.*—There has been very little activity in these districts since the closing of the Montana Lucky Girl property through litigation. Several small productions of bullion were reported from Aura as the result of mill clean-ups and prospect work.

*Contact district.*—Only one small lot of copper carbonate ore, carrying silver and a trace of gold, was shipped from the Contact district as a test from the Delano property, which is opened by a tunnel 300 feet long.

*Dolly Varden district.*—Shipments of lead ore carrying copper, gold, and silver were made from the Kinsley mines.

*Gold Circle district.*—From 7 deep mines, 7,284 tons of ore were mined, containing $57,859 in gold, 3,629 ounces of silver, and 13 pounds of copper, valued in all at $59,784, or an average of $8.21 per ton. The larger part of the output was treated at amalgamation mills. Only 16 tons, containing a trace of copper, were shipped directly to the smelter. The placer yield was valued at $890 in gold and contained 39 ounces of silver. Bullion was recovered from the ores of the Rex mine, treated in the 5-stamp mill on the property by cyanidation. The mine is opened by a vertical shaft 200 feet deep and an adit over 800 feet long. Lessees worked on the Hard-scrabble property and made shipments of gold bullion. Gold bullion was also shipped from sluicing operations from the surface deposits of the Queen mine. The ores of the district occur in veins.

*Jarbidge district.*—The district is situated 95 miles south of Twin Falls, Idaho, and can also be reached from Elko, 74 miles south. In 1911 there were mined in the district 902 tons of gold and silver ore, containing $7,315 in gold and 282 ounces of silver, valued in all at $7,464, or an average value of $8.27 per ton. The Pavlak property was an important producer of siliceous oxidized ores, which were treated in the 75-ton amalgamation and cyanidation plant on the property. The mine is opened by an adit 1,000 feet long and has 1,500 feet of drifts. The North Star was the principal producer. Ores similar to those of the Pavlak property were treated in a mill on the property equipped for amalgamation and cyanidation. The ores of the district occur in veins.

*Railroad district.*—The principal production consisted of lead ore, containing values in silver and a small quantity of copper with a trace of gold, which was shipped to the smelters. The Standing Elk and Tripoli claims yielded most of the copper-lead ore. These properties are opened by an adit 1,500 feet long.

*Tecoma district.*—Ten miles north of Tecoma, on the Southern Pacific Railroad, oxidized lead ore, carrying small quantities of copper, gold, and silver, was shipped from the Jackson property, which is opened by a shaft 100 feet deep and an adit 300 feet long. The ore was loaded at Gartney, Utah, a station on the Southern Pacific.

*Tuscarora district.*—From the treatment of 17,965 tons of ore and old tailings, $17,291 in gold and 20,480 ounces of silver were recovered, valued in all at $28,145, or an average recovery value of $1.57 per ton. Bullion from placer operations contained $295 in gold and 2 ounces of silver. The principal operations were carried on at the Dexter property, at which ore was treated from the mine and dumps in 1911. Two cyanide plants, each of 50 tons capacity, were operated. Some placering was performed on the Nevada, Hydraulic, and Ham properties.

## ESMERALDA COUNTY.

*Mine production of gold, silver, copper, and lead in Esmeralda County, Nev., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 580,226.10 | $11,994,338 | 541,732.37 | $11,198,602 | −38,493.73 | −$795,736 |
| Silver.....do.... | 198,703 | 107,300 | 184,953 | 98,026 | −13,750 | − 9,274 |
| Copper.....pounds.. | 122,593 | 15,569 | 80,477 | 10,060 | −42,116 | − 5,509 |
| Lead.....do.... | 153,310. | 6,746 | 83,418 | 3,754 | −69,892 | − 2,992 |
| Total..... | ..... | 12,123,953 | ..... | 11,310,442 | ..... | − 813,511 |

Sixty-four producers in 1911, against 79 reporting in 1910, mined 574,753 tons of ore, which is 50,771 tons greater than the output in 1910. The total average value of this ore decreased from $23.14 to $19.68 per ton, and the gold and silver value from $23.09 to $19.65 per ton. The bulk of the gold and silver ore was produced from the Goldfield mines and was treated in milling plants equipped for amalgamation, concentration, and cyanidation. The total value of the gold and silver bullion produced was $10,816,603, or an average value of $18.91 per ton. The shipping ore aggregated 2,822 tons and carried $81,522 in gold, 54,975 ounces of silver, 64,683 pounds of copper, and 38,288 pounds of lead, valued in all at $120,467, or an average of $42.69 per ton. The concentrates shipped, the larger part of which consisted of residues produced at the Goldfield mill, aggregated 21,396 tons, containing $344,024 in gold, 47,713 ounces of silver, 15,794 pounds of copper, and 45,130 pounds of lead, valued in all at $373,317, or an average of $17.45 per ton. The placer production of the county consisted of $53 in gold and 1 ounce of silver.

*Gold Mountain district.*—Sixteen deep mines were producers of 393 tons of ore, containing $11,309 in gold, 11,429 ounces of silver, 8,003 pounds of lead, and 10 pounds of copper, valued in all at $17,727, or an average of $45.10 per ton. During assessment work the Blue Chip group yielded gold and silver ore. The vertical shaft on this property is 73 feet deep. The Liberty Bell, Gold Bug, Rob Roy, and Wonder claims were productive of lead ore, carrying principally gold and a small amount of silver. Eight other claims produced only gold and silver.

*Goldfield district.*—The table following shows the production of metals and ores in the Goldfield district in 1910 and 1911:

*Mine production of gold, silver, and copper in Goldfield district, Esmeralda County, Nev., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 538,759.63 | $11,137,150 | 497,637.25 | $10,287,075 | −41,122.38 | −$850,075 |
| Silver.....do.... | 117,598 | 63,503 | 126,406 | 66,995 | + 8,808 | + 3,492 |
| Copper.....pounds.. | 107,282 | 13,625 | 72,998 | 9,125 | −34,284 | − 4,500 |
| Total..... | ..... | 11,214,278 | ..... | 10,363,195 | ..... | − 851,083 |

The following table shows production of gold and silver in the Goldfield district from the time it became productive up to the end of 1911:

*Mine production of gold and silver in Goldfield district, Esmeralda County, Nev., 1903–1911, in fine ounces.*

| Year. | Gold. | | Silver. | | Total value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| 1903..... | 3,418.66 | $70,670 | 287 | $155 | $70,825 |
| 1904..... | 113,293.23 | 2,341,979 | 19,954 | 11,374 | 2,353,353 |
| 1905..... | 91,087.76 | 1,882,951 | 8,589 | 5,188 | 1,888,139 |
| 1906..... | 339,890.20 | 7,026,154 | 15,648 | 10,484 | 7,036,638 |
| 1907..... | 406,756.16 | 8,408,396 | 71,710 | 47,329 | 8,455,725 |
| 1908..... | 236,082.14 | 4,880,251 | 30,823 | 16,336 | 4,896.587 |
| 1909..... | 453,915.25 | 9,383,261 | 33,164 | 17,245 | 9,400,506 |
| 1910..... | 538,759.63 | 11,137,150 | 117,598 | 63,503 | 11,200,653 |
| 1911..... | 497,637.25 | 10,287,075 | 126,406 | 66,995 | 10,354,070 |
| Total..... | 2,680,840.28 | 55,417,887 | 424,179 | 238,609 | 55,656,496 |

The yield of ore from 21 properties aggregated 390,431 tons, which contained $10,287,075 in gold, 126,406 ounces of silver, and 72,998 pounds of copper, valued in all at $10,363,195, or an average of $26.54 per ton. The Goldfield Consolidated mines made the largest yield of gold and silver ores, which contained some copper. Crude shipping ores aggregated 2,033 tons, containing 3,460.51 ounces of gold, 14,845 ounces of silver, and 60,865 pounds of copper, valued in all at $87,011, or an average of $42.80 per ton. The total bullion produced contained 477,573.74 ounces of gold and 64,852 ounces of silver. Oxidized and sulphide ores are produced at nearly all the properties in the district. Development of the Goldfield Consolidated property was carried on at seven vertical shafts, the deepest of which was 1,295 feet; the others range from 330 to 1,000 feet in depth. The ores produced are considered sulphides. The mine and 100-stamp mill were operated the entire year. The principal improvement was the construction of a roasting plant for the re-treatment of concentrates and residues. This plant was not completed, but all of the concentrates, which are given a first treatment by cyanidation and are thereafter known as residues are being stored for future treatment in the furnaces. Part of the residues were shipped to copper smelters

in 1911. According to the printed statement,[1] the property has produced within the year 330,549 tons of ore, of an average value of $32.55 per ton, or $10,760,198.60. Metallurgical losses of $1.81 per ton, or $597,071.14, leave values realized for the year's production of $10,163,127.46, or $30.74 per ton.

The gross expenses of the company, including mining, milling, transportation, general taxation—local, State, and Federal—and all construction have amounted to $2,636,281.42, leaving a net operating realization of $7,526,846.04, an increase of $179,154.23 over the previous year, notwithstanding the fact that the values realized this year were $110,806.71 less than last year. With less gross production in 1911, as stated above, but with a tonnage handled greater by 63,682 tons than that handled in 1910, total costs have been reduced $3.07 per ton during the present year. * * * Four dividends of 50 cents per share, or $2 per share, were made within the year, aggregating $7,118,296. * * * Additional milling facilities are being provided at an approximate estimated cost of $70,000 whereby large economies are anticipated in the treatment of concentrate residues over past cost of shipment. The result of this construction will narrow the company's output to bullion alone, all by-products being handled locally at maximum economy. * * *

| | Production (tons). | Total value. | Average per ton. |
|---|---|---|---|
| Tons milled | 330,062 | $10,586,936.42 | $32.08 |
| Tons shipped | 487 | 173,262.18 | 355.77 |
| Total production | 330,549 | 10,760,198.60 | 32.55 |
| Loss in tailings | | 597,071.14 | 1.81 |
| Values realized | | 10,163,127.46 | 30.74 |

*Production by shafts.*

| | Milling ore. | | | Shipping ore. | | |
|---|---|---|---|---|---|---|
| | Tons. | Average. | Value. | Tons. | Average. | Value. |
| Combination | 55,878 | $24.48 | $1,367,783.37 | | | |
| Mohawk | 106,358 | 22.99 | 2,444,999.31 | | | |
| Red Top[a] | 55,948 | 25.74 | 1,440,069.35 | | | |
| Jumbo[b] | 111,878 | 47.68 | 5,334,084.39 | 487 | $355.77 | $173,262.18 |
| Total | 330,062 | 32.08 | 10,586,936.42 | 487 | 355.77 | 173,262.18 |

[a] Includes Laguna. [b] Includes Jumbo No. 2.

The stoping cost for the year was $2.29 per ton of ore mined, and development cost was $1.06 per ton of ore mined, making a total mining cost of $3.35 per ton. A total of 46,739 feet of development work was performed at a cost of $7.51 per foot. The total cost of mining and milling, which includes concentrate treatment, was $5.62 per ton, or 66 cents per ton less than the previous year. The total operating costs, including construction, were $8.08 per ton, a decrease of $3.07 per ton as compared with cost of $11.15 for the previous year. * * *

The company is now engaged in constructing a plant to treat the residues of the present concentrate-treatment process. Two Edwards duplex roasting furnaces, with 112 foot by 13 foot available hearth area, and one Baker cooler will be housed in a steel building erected for the purpose. One 5 by 18 tube mill, together with tanks, agitators, etc., will be housed in an extension to the present concentrate-treatment plant, together with the necessary dust chambers, storage bins, etc. The plant will cost approximately $73,000 and will effect a saving to the company of approximately $80,000 per year. During the year the mill ran 96.37 per cent of the total time and averaged 9.39 tons per stamp actual running time. * * *

A reduced express rate was taken advantage of which effects a saving of approximately $10,000 per annum, and the company's bullion is now being marketed at the United States mint in Denver, Colo.

Dividends since October 25, 1907, to October 31, 1911, total $5.10 per share of stock issued, or a total amounting to $18,144,430.20.

[1] Annual report for year ending Oct. 31, 1911.

Production at the Florence mine was delayed by the burning of its milling plant. This property is opened by a vertical shaft 1,000 feet deep. Oxidized ores are reported to extend to a depth of between 250 and 300 feet. According to the printed statement [1]—

the property yielded during 1911 milling ore aggregating 48,847.24 dry tons, of a gross value of $298,193.09 in gold, and averaging in value $6.10 per ton. From this was recovered in the mill in bullion, which was shipped to the United States Mint, gold to the value of $250,364.06, and for silver and copper, $1,197.30, making a total value of $251,561.36 for bullion shipped. This is a recovery of gold value of 83.96 per cent. * * * During the year no concentrates were made, certain changes having been effected in the operation of the mill that enabled the values to be extracted to the above extent by amalgamation and cyanidation, thus reducing not only the costs of operation of the mill, but also doing away with the cost of freight and smelting charges on the concentrates, which in 1910 cost the company $44,456.74. This saving more than offsets any slight loss that might have occurred from eliminating concentration.

The ore supply for the mill was mostly secured from the old lease workings, augmented by a body of milling ore opened in February above the 350-foot level, near the old Reilly lease, together with some ore of a low grade stoped above the 530-foot level.

At the close of the year the shaft has been sunk to a depth of 959 feet. * * *

The change of geological conditions as disclosed in the sinking of the main 3-compartment shaft below the 800-foot level is much more favorable for the discovery of ore at depth than any conditions encountered heretofore. At a depth of about 950 feet the shaft enters the dacite, a fact which can not be deemed other than favorable, inasmuch as the large productive ore deposits to the north of this property are all in the dacite and latite flows. * * *

At 10.30 on the evening of December 2 a fire of unknown origin started in the boiler room of the mill, which destroyed the mill in its entirety, together with the gallows frame at the main shaft and the timbering of the shaft to the depth of 35 feet. The fire also destroyed the storehouse connected with the mill and all its contents.

Important work was performed on the Belmont property, which is opened by a shaft 400 feet deep. The ores shipped contained gold and silver, and were reported to consist chiefly of telluride of gold with silver sulphides in a siliceous gangue. Milling and shipping ore was produced from the Combination Fraction property, which is opened by a vertical shaft 611 feet deep. The property was operated by the company and lessees during 1911. The milling ores were treated at the Nevada Goldfield Reduction Works, which were leased by the Combination Co. Lessees worked the Great Bend property, which is opened by a vertical shaft 400 feet deep, with 2,000 feet of drifts. Work was carried on in the Diamondfield Daisy property through the Great Bend workings. An important event in the district was the merging of a number of properties, including the St. Ives. The old workings of this property were operated by lessees who mined a small quantity of gold ore. Shipping ore containing gold, silver, and a small quantity of copper was shipped from the Jumbo Extension mine, which is opened by a vertical shaft 1,070 feet deep and has 5,000 feet of drifts. The Sandstorm and Kendall mines were operated by the company and lessees, producing a small quantity of gold ore. The deepest shaft on these properties is 362 feet. Some ore was taken out by lessees from the Conqueror group, which is opened by a vertical shaft 398 feet deep and has 839 feet of drifts.

*Hornsilver district.*—From 9 properties 381 tons of ore were mined, all but 2 tons of which was shipped to smelters. The total output of the district contained $2,111 in gold, 21,116 ounces of silver, 2,430 pounds of copper, and 8,910 pounds of lead, valued at $14,008, or an

[1] Annual report for year ending Dec. 31, 1911.

average of $36.76 per ton. The Connecter, Silver King, and Sunset were the principal producers. The district is situated 16 miles southwest of Cuprite.

*Lone Mountain district.*—The production of 26 tons of lead-silver ore was made from 3 properties and contained $234 in gold, 5,645 ounces of silver, and 10,112 pounds of lead, valued in all at $3,681, or an average of $141.58 per ton.

*Lida district.*—Lessees of properties in the Lida district used the Pigeon Springs mill for the concentration of ore, and several shipments of concentrates were made with crude ore to the smelter. Both products contained silver, copper, and lead. The district is situated 30 miles southwest of Goldfield.

*Silver Peak district.*—Principally milling ores, containing gold and silver, were mined in the district. The largest producer was the Pittsburg Silver Peak mine. This property is opened by an adit 4,000 feet long, and the ores mined are considered oxidized and sulphide, the former extending to a depth of 100 feet. The ores are treated in the company's 120-stamp mill and 500-ton cyanide plant. According to the printed statements,[1] the company operated 116 stamps of the total number of 120 during the first six months of 1911, and produced gold and silver bullion from 89,487 tons of ore, which yielded an average gross return of $4.84 per ton. During the last half of 1911 an average of 115½ stamps were in continuous operation and 92,546 tons of ore were treated, giving an average gross return of $5.05 per ton.

## EUREKA COUNTY.

*Mine production of gold, silver, copper, and lead in Eureka County, Nev., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 3,942.03 | $81,489 | 5,390.62 | $111,434 | +1,448.59 | +$29,945 |
| Silver.....do.... | 36,047 | 19,466 | 15,273 | 8,095 | − 20,774 | − 11,371 |
| Copper.....pounds.. | 721 | 91 | 2,617 | 327 | + 1,896 | + 236 |
| Lead.....do.... | 672,801 | 29,603 | 61,136 | 2,751 | − 611,665 | − 26,852 |
| Total..... | | 130,649 | | 122,607 | | − 8,042 |

The output of the mines in Eureka County consisted of 15,403 tons of milling ore, from which gold and silver bullion valued at $98,839 was extracted. The average recovery value was $6.42 per ton. The smelting ore shipped aggregated 231 tons and carried gold, silver, copper, and lead, valued in all at $14,591, an average of $63.16 per ton. The placer production reported by six operators amounted to $9,160 in gold and 30 ounces of silver.

*Cortez district.*—Lead ores containing some gold and silver and a small quantity of copper were shipped from the district, mined from the Rossi and Garrison properties.

*Eureka district.*—Ore aggregating 15,484 tons was mined from 7 properties, which yielded milling grade ore amenable principally to cyanide treatment. The district output contained $101,715 in gold,

[1] Statements to stockholders dated Aug. 7, 1911, and Feb. 12, 1912.

5,584 ounces of silver, and 27,570 pounds of lead, valued in all at $105,915, or an average value of $6.84 per ton. Ore containing lead was shipped directly to the smelter. The largest producer of milling ore was the Windfall mine, which is opened by a vertical shaft 540 feet deep and has 7,000 feet of drifts. The ores are oxidized, with a siliceous gangue, and oxidization extends in depth as far as the mine has been developed. The milling plant and mine were operated from May until the end of the year. It is proposed to increase the tonnage capacity of the 100-ton cyanide plant now on the property. The Silver Conner group is opened by a shaft 450 feet deep and has an adit 2,300 feet long. The ore mined is oxidized with a basic gangue and has a large percentage of iron and some lead. The production in 1911 was considered as a test to try out a 10-stamp mill built during the year. The ore was treated by crushing in cyanide solution with stamps and tube mill. Compressed-air agitation and vacuum filtration were used.

*Lynn district.*—Twenty miles north of Carlin, Nev., placer production was made from 6 properties, which yielded bullion containing $9,160 in gold and 30 ounces of silver. The output was made by sluicing, rocking, and dry washing the stream gravel. There was no ore mined in the district, although several prospecting parties are attempting to find mineralized veins by crosscutting the formation.

*Palisade or Safford district.*—Lessees shipped in a small way from the Zenoli property lead sulphide ore carrying silver with small copper and gold values. The property is developed by an incline shaft.

## HUMBOLDT COUNTY.

*Mine production of gold, silver, copper, and lead in Humboldt County, Nev., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 70,554.26 | $1,458,486 | 59,197.17 | $1,223,714 | −11,357.09 | −$234,772 |
| Silver.....do.... | 280,632 | 151,541 | 255,367 | 135,345 | − 25,265 | − 16,196 |
| Copper.....pounds.. | 7,182 | 912 | 11,979 | 1,497 | + 4,797 | + 585 |
| Lead.....do.... | 107,063 | 4,711 | 71,850 | 3,233 | − 35,213 | − 1,478 |
| Total..... | ..... | 1,615,650 | ..... | 1,363,789 | ..... | − 251,861 |

In 1911 there were 9,665 tons of ore mined and reported by 95 producers, or 3,017 tons more than was produced at 71 properties in 1910. The total average value of this ore decreased from $242.67 to $140.55 per ton and the gold and silver value from $241.83 to $140.06 per ton. Most of the ore was milled, yielding $1,007,576 in gold and silver bullion, largely by amalgamation, which was recovered from 7,407 tons of ore and 1,135 tons of old tailings. In 1910 the tonnage treated by the same process aggregated 6,147 tons, which yielded gold and silver bullion containing $1,443,232 in gold and 182,974 ounces of silver. There were 294 tons of concentrates produced, in addition to the gold and silver bullion, yielding at the smelters $86,742 in gold, 12,493 ounces of silver, 567 pounds of lead, and 60 pounds of copper, valued in all at $93,395, or an average value of $317.67 per ton. Crude

ores shipped directly to smelters amounted to 1,111 tons, containing $170,923 in gold, 153,705 ounces of silver, 8,593 pounds of copper, and 71,283 pounds of lead, valued in all at $256,669, or an average of $231.02 per ton. In 1910, there were shipped to smelters 484 tons of ore which contained gold, silver, copper, and lead, yielding $64,302, or an average of $132.85 per ton. Placers in this county were productive of $5,280 in gold and 134 ounces of silver.

*Antelope and Imlay districts.*—The Nevada Superior, Indian Ike, and Imlay properties were the principal producers of lead sulphide ore carrying a little copper and considerable values in silver and gold. The Nevada Superior mine is opened by a vertical shaft 330 feet deep and 4,500 feet of tunnels and drifts. Carbonate lead ore extends to a depth of 100 feet. During 1911 a new 75-ton concentrating plant was under construction and is expected to be completed in March, 1912. The Imlay property is opened to a depth of 225 feet and has a 10-stamp amalgamation and concentration mill. This mill was not operated during 1911.

*Dun Glen, Central, or Chafey district.*—In this district 1,281 tons of ore were produced during 1911, the larger part of which, or 1,235 tons, was milled and the remainder was shipped crude to smelters. The total metal content was $22,894 in gold, 7,731 ounces of silver, 1,850 pounds of lead, and 28 pounds of copper, valued in all at $27,078, or an average of $21.14 per ton. A trial shipment was made from the Mayflower mine, which was operated by lessees who milled the ore and shipped bullion and concentrate.

*Echo, Rye Patch, Star, or Unionville district.*—The Rye Patch property was developed by lessees in 1911, and produced a small amount of sulphide ore which was shipped to the smelter. The Arizona mine was under development by new owners in 1911. A new 40-ton cyanidation mill was erected and operated until interference by cold weather.

*Gold Run or Adelaide district.*—Gold and silver bullion, crude ore, and a small amount of copper matte were produced in 1911. The total metallic content was $2,625 in gold, 3,256 ounces of silver, 10,209 pounds of copper, and 24,727 pounds of lead, in all valued at $6,740, or an average value of $44.05 per ton. Lessees of the Gold Ledge mine made the largest production of bullion from ore which was treated in a 6-foot Lane slow-speed mill. Lead sulphide and carbonate ore, with considerable values in silver, was shipped from the Silver Shield property. It was reported that ore carrying as high as 25 per cent zinc can be mined from the property, which is opened by a crosscut tunnel 300 feet long and by 100 feet of drifts on the vein. The Black Diamond property was also operated and is opened by an adit 600 feet long.

*Grandpap district.*—In the Grandpap Canyon, 26 miles south of Winnemucca, is situated the Washaki group, from which gold and silver ore was taken. The property is developed by a vertical shaft 60 feet deep and has 20 feet of drifts. Both oxidized and sulphide ores with siliceous gangue were found on the property.

*Kennedy district.*—The Fourth of July and Virginia properties were the only producing mines in the camp, and yielded oxidized ores containing large values in gold and silver with a little lead.

*National district.*—The chief producer was the National mine, which yielded a large part of the gold and silver output of Humboldt

County. Gold and silver bullion was recovered by the amalgamation process, and concentrates and crude smelting ore were shipped. The property is developed by 4 tunnels, each connecting with incline shafts from the surface of Charleston Hill. Improvements were made in the milling equipment by the replacement of the Lane mill with 5 stamps and the addition of 2 Wilfley tables. The mill is also equipped with Johnston tables. The geology of the district by Lindgren [1] follows:

The northern end of the Santa Rosa range, from the Oregon line for almost 16 miles south to Canyon Creek, is made up of a succession of basalt flows, interbedded with tuffs. Some of these flows are scoriaceous, others massive; they are well exposed north of Eight-Mile Creek, where the whole series, over 2,000 feet in thickness, dips east at gentle angles. They form part of the great volcanic area of the Columbia River lavas and extend far to the north, east, and west of National. They were erupted in early Tertiary time, a time of intense volcanic activity all over the Cordilleran region. The interbedded tuffs, volcanic muds, and sandstones of volcanic origin are well shown in several cuts and tunnels near National.

At one time during this great epoch of volcanism the character of the lavas changed. Instead of black basalts, light-colored and siliceous rhyolites were for a time the lavas which poured out of the volcanic vents. The thickest of these flows now forms Buckskin Mountain, which has an elevation of 8,700 feet. At the same time dikes and masses of rhyolite and obsidian (volcanic glass), generally trending north and south, forced their way up through the basalts and tuff beds, in places disturbing them greatly; big blocks of basalt are sometimes embedded in the rhyolite. Such rhyolite intrusions are the dikes on Radiator and Auto hills, and the great mass, which extends for a couple of miles from the ridge overlooking Three-Mile Creek, occupies the west side of Charleston Hill, and reaches nearly to Eight-Mile Creek.

A third and latest intrusion is that occupying the northern end of Charleston Hill above the National mine. This dark, fine-grained rock, which is of importance because of the ore bodies in it, may provisionally be called an andesite.

After the eruption of rhyolite and andesite followed the formation of the mineral veins. But there is also reason to believe that volcanic action continued after this and that the rhyolite, except possibly in its highest point, became covered with successive flows of basalt, such as are exposed to the east of Buckskin Peak. The basalts are thin-flowing lavas and easily spread out in even sheets, while the rhyolites are thick and viscous, and are apt to pile up in heavy masses like the flows of Buckskin Peak.

Basalt dikes may in fact be found cutting those of rhyolites and showing that the volcanic activity was complete and long continued.

Shortly after the eruptions of rhyolite and andesite, fissures were opened trending north and south, mainly along the dikes, sometimes also breaking into the basalt flows and the tuffs. The fissures are generally small, rarely over a few feet in width, and commonly much less. The fissure filling is mainly quartz, with drusy structure, and the characteristic combination of metals is antimony (as stibnite or sulphide of antimony), iron (as pyrite or marcasite), gold and silver. Lead, copper, and zinc are generally absent. Cinnabar has been observed at a few places. The veins throughout bear evidence of having been deposited by hot, ascending springs at a moderate depth below the surface.

The majority of the veins are clearly dependent upon the rhyolite eruptions; they sometimes carry considerable amounts of stibnite, and the silver values usually prevail over those of gold. Thus far none of them has yielded any considerable amount of shipping ore.

The case of the National vein is somewhat different. It is as stated mainly contained in an andesite rock, but it also cuts into basalt and rhyolite. Though its ore yields some antimony (both as stibnite and ruby silver), the quartz is distinctly different from that of other veins, being more massive and milky and less drusy. There is in fact some reason to believe that its mineralization took place a little later than that of the veins following the rhyolite dikes.

This quartz vein, of very moderate thickness, contains along a well-defined shoot a most remarkably rich bonanza ore, consisting of coarse and hackly pale gold (possibly electrum) firmly embedded in the white quartz. An interesting characteristic is that within the bonanza shoot, rich and barren quartz may intermingle capriciously.

[1] Lindgren, W., Rough field notes in National Miner, Aug. 18, 1911, and also delivered before the Geological Society of Washington: Min. and Eng. World, Dec. 9, 1911, p. 1175.

The gold is not a secondary deposit; in fact, there is scarcely any evidence at all of such secondary solution and redeposition of the gold by descending surface waters, while there is evidence that some of the silver has been leached by surface waters and redeposited as ruby silver. There is also some secondary marcasite. The shoot has been followed for a distance along the dip of the vein of about 800 feet, the lowest level being opened by a crosscut from Charleston Gulch. The production of this extraordinary bonanza since its discovery two years ago is said to have been no less than $2,000,000, mainly in gold. Most of the ore had a tenor of from $10 to $40 per pound. Some high silver values were found at the surface, but the apex of the gold shoot was not encountered until about 60 feet below the surface. No placers have been found in Charleston Gulch or in Eight-Mile Creek, in spite of the fact that a great deal of rock has been removed by erosion. Hence it is probable that this gold shoot never reached the surface, and that no other of a similar nature existed within the rock volume carried away by erosion. The almost inevitable conclusion is that such shoots must be scarce below the present surface.

*Paradise or Spring City district.*—From the treatment of 1,142 tons of old tailings and crude ore by the cyanidation and amalgamation processes, there were produced in this district $2,036 in gold and 8,344 ounces of silver. There was also shipped to the smelter one lot of crude ore, containing gold and silver. The largest production came from the treatment of tailings from the old Spring City mill by straight percolation and cyanidation. The Bodenia claim, which is opened by an inclined shaft 165 feet deep and two tunnels 75 feet long, produced siliceous ore which was treated in a small 4-wheel roller mill operated by horsepower. The ore was run through sluice boxes and over blankets. The Saxonia property is opened by a shaft 100 feet deep. There is a 2-stamp amalgamation mill and concentrator on the property.

*Rosebud district.*—From the operations of 9 deep mines and 3 placers in the district $7,501 was recovered from ore and bullion. From 98 tons of ore there were produced $1,050 in gold, 7,470 ounces of silver, 770 pounds of copper, and 2,172 pounds of lead, valued in all at $5,203, or an average of $53.09 per ton. The placer yield amounted to $2,249 in gold and 93 ounces of silver. Of the deep mines, the Durango Girl, Big Six, Brown Palace, and Dreamland properties were operated, and the Discovery placers, situated 1 mile west of Rosebud, were operated for about 60 days.

*Seven Troughs district.*—Twenty-two operators made reports of production of milling and shipping ore and concentrates in the Seven Troughs district, from which there were produced $348,255 in gold and 153,079 ounces of silver, valued in all at $429,387, or an average of $88.81 per ton. The ore milled, which was treated by amalgamation and concentration, aggregated 4,671 tons and yielded bullion containing 14,391.22 ounces of gold and 43,060 ounces of silver, valued in all at $320,315, or an average of $68.58 per ton; and 161 tons of concentrates containing 1,932.74 ounces of gold and 8,052 ounces of silver, valued at $44,221, or an average of $274.66 per ton. Crude smelting ore shipped directly to smelters amounted to 164 tons and contained $10,809 in gold and 101,967 ounces of silver, valued in all at $64,851, or an average of $395.43 per ton. The Coalition property, which is a combination of the Kindergarten, the Wihuja, and the Therian mines, produced the largest values in gold and silver bullion and concentrate. This property is developed by a vertical shaft 425 feet deep and an incline shaft 465 feet deep. It has 4,260 feet of drifts, crosscuts, and upraises. This mine and the 10-stamp amalgamation and concentration mill were operated

throughout the year. A 50-ton cyanide plant was added to the equipment. The ores produced are considered sulphides with a siliceous gangue. The Fairview mine, operated by lessees, is developed by a vertical shaft 700 feet deep. The ore produced is straight sulphide, and is hauled to the custom mill of the Darby Co. at Mazuma, where it is sold, and the smelting ores are shipped directly to smelters. Gold and silver ore was mined from the Signal Peak property, which is opened by a shaft 80 feet deep. Lessees operated the Rough Lot and the Lookout claims of the Mazuma Hills group, producing bullion from gold and silver ore shipped to the Darby Mill in the district. The property is developed by 7 vertical shafts. There is a 10-stamp mill on the property, but it was not operated in 1911.

*Sierra district.*—Placers in Barber Canyon, some of them operated by Chinamen, yielded bullion containing $1,567 in gold and 22 ounces of silver.

*Spring Valley district.*—The dredge of the Federal placer mines was operated only seven months during 1911 on stream-bench gravel and sand, and produced a small amount of bullion ranging in gold from 0.696 to 0.730 fine.

*Winnemucca and Barrett Springs district.*—Fourteen reports were received from operators giving a production of 960 tons of ore, which contained $27,802 in gold, 28,714 ounces of silver, and 21,320 pounds of lead, valued in all at $43,979, or an average value of $45.81 per ton. Of the total ore, 678 tons were shipped crude to the smelters and contained 431.75 ounces of gold, 27,954 ounces of silver, and 21,320 pounds of lead, valued in all at $24,701, or an average of $36.43 per ton. Ores treated by the amalgamation process aggregated 282 tons and yielded bullion containing 913.17 ounces of gold and 760 ounces of silver, having a total value of $19,279, or an average of $68.37 per ton. The largest production of oxidized and sulphide ore was mined from the Nineteen Ten property, which is opened by an incline shaft 200 feet deep. The oxidized ores are reported to extend to a depth of about 100 feet. Most of the work was performed by lessees. The Blue Bell property was a producer of oxidized lead ore and is developed by a shaft 150 feet deep. The Rexall mine was the largest producer of gold and silver bullion, recovered from the ore by amalgamation in a 4-foot pan arrastre, which has a capacity of about 400 pounds a day. The property is opened by shafts and tunnels aggregating about 800 feet.

### LANDER COUNTY.

Through the operations of 20 producers 16,170 tons of ore were mined, which is 3,686 tons greater than was mined by 16 producers in 1910. The total average value per ton increased from $6.70 to $9.35 per ton, and the gold and silver value from $6.29 to $9.12 per ton. The placer yield was made by 11 operators and the total output of the county was valued at $122,882, which consisted of $69,469 in gold, 160,680 ounces of silver, 6,058 pounds of copper, and 66,142 pounds of lead. Of the ore produced, 1,345 tons were shipped directly to the smelters, yielding $41,009 in gold, 85,055 ounces of silver, 5,710 pounds of copper, and 60,104 pounds of lead, valued in all at $89,507, or an average of $66.55 per ton. At milling plants

887 tons of ore and 12,000 tons of old tailings were treated by amalgamation and cyanide processes, yielding $35,260 in gold and silver bullion. Milling plants crushed 1,938 tons of ore, which was treated by concentration and yielded 219 tons of concentrate, which contained $7,106 in gold, 35,941 ounces of silver, 348 pounds of copper, 6,038 pounds of lead, valued in all at $26,470, or an average of $120.86 per ton. The placer bullion produced contained $7,092 in gold and 67 ounces of silver.

*Battle Mountain district.*—The district yield of ore and bullion produced by 4 deep mines and 10 placer operators aggregated $8,326. The deep mines produced 114 tons of ore, containing $320 in gold, 2,566 ounces of silver, 551 pounds of copper, and 22,467 pounds of lead, valued in all at $2,760, or an average of $24.21 per ton. The placers yielded $5,541 in gold and 47 ounces of silver, most of which was taken out by "dry washing" of the gravels. Lead sulphide ore, containing silver, was shipped from the Buffalo property, which is opened by a vertical shaft 30 feet deep. Carbonate and sulphide ores, carrying silver and gold values and a trace of copper, were produced from the Grant property.

*Galena district.*—Three deep mines were operated in 1911, and 12,426 tons of old tailings and ore produced $24,618 in gold, 54,155 ounces of silver, 3,240 pounds of copper, and 12,562 pounds of lead, valued in all at $54,290. The crude smelting ores of shipping grade amounted to 426 tons, and contained $18,364 in gold, 16,070 ounces of silver, 3,240 pounds of copper, and 12,562 pounds of lead, valued in all at $27,809, or an average of $65.28 per ton. The Iron Canyon and Cortez properties were the principal producers.

*Hilltop district.*—From two properties 180 tons of ore were produced, carrying gold, silver, and lead, which had an average value of $26.43 per ton. Sulphide iron ores containing values in gold were produced from the Red Top mine, which is opened by two adits aggregating 2,000 feet in length and a vertical shaft 85 feet deep. The management reports that the construction of a 100-ton concentration plant was begun in November.

*Jackson district.*—The Gold Park, Gold Basin, and two other properties were operated in 1911, producing oxidized ore, part of which produced bullion extracted by amalgamation in a 3-stamp mill on the Gold Park property. The ores of the Gold Basin and two other properties were shipped directly to the smelter. The total output from the four properties aggregated 407 tons, yielding $11,130 in gold, 2,003 ounces of silver, 295 pounds of copper, valued in all at $12,229, or an average of $30.05 per ton.

*Reese River district.*—Seven mines in the district produced 3,043 tons of ore, valued for the gold, silver, copper, and lead, at $77,199, or an average of $25.37 per ton. The larger part, or 1,938 tons, was treated at concentration mills, yielding 219 tons of concentrate, which contained $7,106 in gold, 35,941 ounces of silver, 348 pounds of copper, and 6,038 pounds of lead, valued in all at $26,471, or an average of $120.87 per ton. Crude shipping ores aggregated 568 tons, containing $10,970 in gold, 64,733 ounces of silver, 1,624 pounds of copper, and 23,029 pounds of lead. Gold bullion was recovered from 537 tons of ore, containing $3,724 in gold, and 918 ounces of silver, valued in all at $4,211, or an average of $7.84 per ton. The principal producer was the Austin Manhattan property.

The development work was carried on from the 400-foot vertical shaft. Sulphide ores with a siliceous gangue, containing small amounts of zinc and lead, were crushed, classified, and treated dry in a 30-ton electrostatic mill. Gold bullion and concentrates were recovered from the ores produced at the Kingston mine, which is opened by an incline shaft 100 feet deep. The bullion was recovered by amalgamation and cyanidation in a 30-stamp mill operated by water power. Sulphide silver ore, carrying small values in lead and copper, was shipped from the True Blue property, which is developed by several tunnels from 200 to 1,400 feet long. The deepest shaft on the property is 850 feet. A 75-ton cyanide mill is reported under construction. The Maricopa mine is being equipped with a 20-stamp mill.

## LINCOLN COUNTY.

*Mine production of gold, silver, copper, and lead in Lincoln County, Nev., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 1,687.13 | $34,876 | 366.78 | $7,582 | −1,320.35 | −$27,294 |
| Silver.....do.... | 54,571 | 29,468 | 174,774 | 92,630 | + 120,203 | + 63,162 |
| Copper.....pounds.. | 7,653 | 972 | 17,382 | 2,173 | + 9,729 | + 1,201 |
| Lead.....do.... | 935,255 | 41,151 | 455,490 | 20,497 | − 479,765 | − 20,654 |
| Total..... | ..... | 106,467 | ..... | 122,882 | ..... | + 16,415 |

Operators of 14 properties reported the production of 25,643 tons of ore, which is 21,333 tons more than was reported by 18 operators in 1910. The total average value of the ore decreased from $24.70 to $4.79 per ton, and the gold and silver value from $14.93 to $3.91 per ton. Nearly all of the ore output, aggregating 23,621 tons, was shipped directly to smelters and contained $6,001 in gold, 170,397 ounces of silver, 17,028 pounds of copper, 349,344 pounds of lead, valued in all at $114,162, or an average of $4.83 per ton. At concentration mills, 912 tons of ore yielded 393 tons of concentrates, containing $983 in gold, 4,090 ounces of silver, 354 pounds of copper, and 106,146 pounds of lead, valued in all at $7,972, or an average of $20.28 per ton. There were 220 tons of ore treated by amalgamation and hyposulphite processes, by which bullion was extracted valued at $750, or an average recovery of $3.41 per ton.

*Chief district.*—A small amount of ore was treated in a 20-ton cyanide plant by simple percolation from the Panaca group of the Gold Chief property, which is opened by an incline shaft 432 feet deep and by about 1,000 feet of drifts.

*Eagle Valley district.*—Three properties produced gold and silver ore amounting in value to $213. The Bull Hill, the B. and C. group, and the White Horse were the producing properties. On the last property a small leaching plant with a capacity of 4 tons per day treated the ores produced by the hyposulphite process.

*Ferguson or Delamar district.*—No active mining was reported in the district in 1911, and the only production consisted of some residues shipped, which resulted from the final clean-up of the Delamar mill.

*Pioche district.*—The ore mined by 8 producers amounted to 25,392 tons, which includes the shipment and treatment of 890 tons of old tailings. The total output of the district contained $5,953 in gold, 174,271 ounces of silver, 17,382 pounds of copper, and 455,490 pounds of lead, valued in all at $120,987, or an average of $4.77 per ton. This low average value is accounted for by the shipment from one property of a large tonnage of oxidized manganese-iron ore carrying considerable lime, which was valuable to the smelters as a flux, and carried an average of nearly 10 ounces of silver per ton of ore, besides small quantities of copper and lead. An extension of the railroad to reach the large dump of tailings of the Prince Consolidated mine was under construction. The tailings are to be shipped for further treatment directly to smelters. The Day and Bristol properties have been consolidated and are now under one management. A large tonnage of ore was shipped from this property, and smaller outputs were made from the Mendha group and the Highland Mary mine.

LYON COUNTY.

Fifty-one producers reported the mining of 16,745 tons of ore, which is 5,628 tons greater than was mined by 28 producers in 1910. The ore produced only gold and silver, and the average value per ton decreased from $11.11 in 1910 to $6.69 in 1911. The total production of placers and crude ore was valued at $112,967 and contained $108,471 in gold, 7,839 ounces of silver, and 2,727 pounds of copper. The ore was largely treated by the amalgamation process, followed by cyanidation, and the gold and silver bullion recovered from it was valued at $109,006. Crude ore shipped directly to smelters aggregated 99 tons and contained $1,729 in gold, 2,595 ounces of silver, and 2,727 pounds of copper, valued in all at $3,445, or an average of $34.80 per ton. The placer yield amounted to $509 in gold and 13 ounces of silver.

*Ramsey district.*—Three small productions of gold ore and some silver bullion from properties leased in the district comprise the total output, which aggregated $1,857 in value.

*Silver City district.*—The output of mines of the Palmyra, Devils Gate, Chinatown, and Indian Springs sections is included in this district. There were 41 reports received from producers whose ore yield aggregated 16,454 tons, containing $103,208 in gold and 5,206 ounces of silver, valued in all at $106,483, or an average recovery of $6.44 per ton. All the ore was treated at milling plants, producing gold and silver bullion. About 5,000 tons of the ore were treated at the McTigue mill, at which the ore is amalgamated. Most of the ore treated at this mill was mined from the Silver Hill and Hartford properties. The tailings from these mill runs are usually hauled away from the mill by the owners of the ore and given a treatment by the cyanide process. One of the principal producers was the Buckeye mine, usually leased to small operators, which is opened by an incline shaft 130 feet deep. The Haywood mine was productive of free milling quartz containing gold and silver, which was treated at a neighboring mill. The property is opened by an incline shaft 400 feet deep and has about 4,000 feet of drifts. The Santiago, Ida, and Snell properties also produced gold and silver from siliceous ores. The Como-Eureka mine, which changed ownership during the year, produced gold and silver bullion from the operation of the amalga-

mation mill on the property during July and August. The cyanide plant on the property was not operated. The mine is opened by a vertical shaft 350 feet deep, and it is reported that the oxidized ores extend to the 300-foot level. Gold bullion was recovered from the placer operations in Gold Canyon on the King placer. Other deep mine producers from which reports were received were the Northern Bell, Oest, and Vivian.

*Talapoosa district.*—Lessees shipped an experimental lot of ore from the Talapoosa mine. The ore is partly oxidized and carries gold and silver with a trace of copper. The property is opened by several vertical shafts, the deepest of which is 100 feet, and the drifts on the property aggregate 500 feet, with an adit 200 feet long. It is reported that the oxidized ore extends to a depth of 100 feet.

*Yerington or Mason district.*—The ore production of the district was quite an important one in 1911 in preparation of the opening of the Mason Valley smelter at Thompson, near Wabuska, where all the ores, principally from the Mason Valley and Nevada-Douglas properties, were shipped but not sampled or smelted. The copper ores produced, which were half oxidized and half sulphide, carried a little gold and silver. In the Nevada-Douglas property the oxidized ores are reported to extend to a depth of 500 feet. Only 108 tons of ore that produced gold and silver bullion were treated in the district, and 12 tons, containing copper and gold with small values in silver, were shipped to the smelter. The method of working the Mason Valley [1] Copper mine is stoping by the shrinkage system.

> The stopes have an average width of approximately 40 feet and extend in a north and south direction from 100 to 400 feet in length. The stope floor is started at a point from 12 to 15 feet above the level, and chutes are established from 30 to 40 foot centers. These chutes discharge in the level below. As stoping advances the stope is kept full of broken ore, only enough being drawn each day to allow the operation of machines on the back. It is found that something less than 50 per cent of the ore broken is removed, the broken ore remaining in the stope until the next working level above has been reached, at which time the entire accumulation is available. This system has been quite thoroughly tried out and no difficulties have been encountered: all the ore in the body can be mined with the removal of a minimum amount of waste. * * *
>
> The ore * * * cars, containing 2 tons each, discharge directly into a Blake crusher having an opening 15 by 30 inches. The ore is crushed to about 6 inches in size and discharged on a 22-inch belt conveyor. From this conveyor the ore is distributed into any of 4 large receiving bins, which hold 200 tons each. The bins are equipped with air-operated gates, by means of which the tramway buckets can be quickly and properly filled. The tramway is operated entirely by gravity. The discharge terminal is 6,250 feet from the upper or loading terminal, is 600 feet lower in elevation than the loading terminal, and located near the town of Mason. * * *
>
> The smelter is located 16½ miles north of Mason and 2 miles northwest of Wabuska, a station on the Goldfield branch of the Southern Pacific Railroad. The site chosen for the smelting plant has proven very satisfactory, allowing a convenient arrangement of buildings, railway tracks, and offering ample room for slag disposal. The contour of the ground has afforded every advantage to be taken in handling material by gravity. * * *
>
> The smelter construction was begun in November, 1910. The first train of ore was received at the smelter December 2, 1911. The blast-furnace department was not completed until January 1, 1912. One blast furnace was blown on January 6, 1912.

The ores from the Mason Valley, Nevada-Douglas, and other properties in the Yerington district are delivered to the smelter by the Nevada Copper Belt Railway. All ore, fuel, etc., originating on other lines and delivered by the Southern Pacific at Wabuska is switched from Wabuska to the smelter by the Nevada Copper Belt Railway.

[1] Annual report for year ending Dec. 31, 1911.

MINERAL COUNTY.

Reports were received from 56 producers in 1911, showing an output aggregating 10,829 tons of ore, which is 7,914 tons less than was reported by 68 producers in 1910. The average value of the ore decreased from $26.21 per ton in 1910 to $17.98 per ton in 1911, and the gold and silver value per ton from $24.22 to $17.07. Gold and silver milling plants received the bulk of the ore, or 7,422 tons, and re-treated 1,710 tons of old tailings, the combined yield of which, by amalgamation and cyanidation processes, was $110,162 in gold and silver bullion. Smelting establishments received 956 tons of ore, containing $6,667 in gold, 88,577 ounces of silver, 12,868 pounds of copper, and 137,344 pounds of lead, valued in all at $61,402, or an average of $64.23 per ton. The bullion yield reported by placer operators amounted to $6,699 in gold and 271 ounces of silver.

*Aurora district.*—The treatment of old tailings, reported by 4 operators, including the treatment of 19 tons of ore, produced bullion containing $7,016 in gold and 818 ounces of silver. Most of the tailings had been washed over from the Bodie mines, which are situated in California.

*Buena Vista or Oneta district.*—Ore carrying values in gold and a small quantity of lead was mined from the Indian Queen property.

*Columbus or Candelaria district.*—Six producers in the district reported the shipment of 278 tons of ore to the smelter, containing $1,517 in gold, 7,637 ounces of silver, 266 pounds of copper, 6,164 pounds of lead, valued in all at $5,876, or an average of $21.15 per ton. The largest output was made from the Swastika property, which is opened by a vertical shaft 312 feet deep and has about 1,000 feet of drifts. The ore contains good values in silver and gold, with some lead and copper and a small amount of zinc. During assessment work the Lucky Hill mine produced some silver ore carrying a small amount of gold. The property is opened by a vertical shaft 250 feet deep.

*Gold Range district.*—Small lots of copper ore were shipped from the High Ore property. The Wagner property produced shipping ore carrying small values in silver.

*Hawthorne section.*—Reports of 9 producers in the Lucky Boy and Palmica districts aggregated 1,323 tons of ore, almost half of which was treated at concentrating mills, yielding lead concentrate carrying good values in silver and a trace of gold. Crude smelting ore, aggregating 422 tons, was shipped, which contained 15.93 ounces of gold, 67,882 ounces of silver, 1,709 pounds of copper, and 81,069 pounds of lead, valued in all at $40,168, or an average of $95.18 per ton. The ore sent to gold and silver mills, treated chiefly by amalgamation, amounted to 185 tons and yielded $2,815 in gold and 30 ounces of silver. The total output of the district was valued at $62,530, and the total tonnage mined averaged in value $47.26 per ton.

*Pine Grove district.*—The yield of 1,024 tons of ore, made by 3 producers, was all treated by amalgamation, containing 576.34 ounces of gold and 81 ounces of silver. The Wheeler mines produced ores which were partly oxidized and partly sulphide, and were treated in a 5-stamp amalgamation and concentration mill on the property, from which concentrates were produced but not shipped. The mine is opened by a vertical shaft 300 feet deep. It is said that the

oxidized zone extends 600 feet below the apex of the vein. From the Wild Horse property quartz and porphyritic ore, carrying gold, was treated in a stamp mill having a capacity of 10 tons and equipped for amalgamation.

*Rawhide district.*—Seventeen deep mines and 7 placers yielded $76,253 in gold and 45,011 ounces of silver. The ore produced was of milling grade, with the exception of 36 tons shipped directly to the smelter. At gold and silver mills 5,962 tons were treated, yielding bullion and a small quantity of concentrate. The total value of the ore output was $93,266, or an average value of $15.51 per ton. The yield from the surface placers, chiefly by dry washing, was $6,699 in gold and 271 ounces of silver. The properties of the Rawhide, Queen, and Coalition companies were the largest producers. The deepest vertical shaft on the Coalition property is 600 feet. The ores from this mine are mostly oxidized, but part are sulphide. The oxidized ores extend to the 300-foot level. The mine and plant were operated mainly by lessees during 1911. The deeper levels of the mine opened up sulphide ores carrying principally silver values. On the Queen property the deepest vertical shaft is 500 feet. The 10-stamp mill and 50-ton cyanide plant equipped with classifiers, filter, etc., was started in October on the treatment of tailings from the amalgamation mill.

*Santa Fe district.*—Four operators reported the production of milling and shipping ore aggregating 158 tons, which contained $1,191 in gold, 2,902 ounces of silver, 1,256 pounds of copper, and 26,393 pounds of lead, valued in all at $4,074, or an average of $25.78 per ton. The larger part of the ore was amalgamated, producing besides bullion some lead concentrate, which contained silver and gold values. The shipping ore amounted to 48 tons and contained lead, copper, and good values in gold and silver. The principal producer was the Silver State group, yielding carbonate lead ores, and some siliceous gold ores were produced from the Julia claim. The property is opened by an adit 600 feet long. The mill is situated on the Southern Pacific Railroad, near Luning, and is 5 miles from the mine. The ore is treated in a 7-foot Lane mill, crushing to a fineness ranging from 60 to 100 mesh, amalgamating in battery and on plates, and using classification and concentration of crushed material. The property of the Western Mineral Co. was leased and produced lead ore carrying values in silver and gold and a small quantity of copper. This property is opened by a vertical shaft 215 feet deep.

*Silver Star district.*—Most of the ore mined by 7 operators was shipped directly to smelters and aggregated 109 tons, containing 54.63 ounces of gold, 4,822 ounces of silver, 35 pounds of copper, and 6,103 pounds of lead. Three lots of ore produced gold and silver bullion. The total value of the district output was $4,190, or an average of $34.63 per ton. The Ibex, Moho, Spring Valley, and Tennessee mines were productive.

*Walker Lake district.*—Four producers mined and shipped 141 tons of ore carrying gold, silver, and lead values, and having a total value of $2,375, or an average value of $16.84 per ton. The Walker Lake mine, in Reese River Canyon, was the principal producer of oxidized and sulphide ore, carrying gold and silver, which was treated in a 5-stamp mill by amalgamation and concentration, producing

bullion and concentrates. The concentrates were not shipped. The property is opened by an adit 300 feet long and an incline shaft 150 feet deep.

NYE COUNTY.

*Mine production of gold, silver, copper, and lead in Nye County, Nev., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 177,147.65 | $3,661,967 | 174,985.72 | $3,617,276 | −2,161.93 | −$44,691 |
| Silver.....do.... | 10,550,303 | 5,697,163 | 10,918,263 | 5,786,679 | + 367,960 | + 89,516 |
| Copper.....pounds.. | 2,038 | 259 | 2,264 | 283 | + 226 | + 24 |
| Lead.....do.... | 15,019 | 661 | 2,808 | 127 | − 12,211 | − 534 |
| Total..... | ..... | 9,360,050 | ..... | 9,404,365 | ..... | + 44,315 |

Ninety-nine operators reported the production of 525,489 tons of ore, which is 913 tons greater than was reported by 95 operators in 1910. The total average value of the ore decreased from $17.58 per ton in 1910 to $17.55 in 1911. The total value is practically all for gold and silver. The greater part of the output was treated at cyanidation and concentration mills, which yielded from 475,950 tons gold and silver bullion, valued at $5,895,487, or an average of $12.39 per ton. Concentrates from 6 mills aggregated 2,817 tons and contained $314,842 in gold, 1,939,383 ounces of silver, 231 pounds of copper, and 1,337 pounds of lead, valued in all at $1,342,804, or an average of $476.67 per ton. Smelting ores were shipped from the county aggregating 35,376 tons, which contained $617,161 in gold, 2,581,369 ounces of silver, 2,033 pounds of copper, and 1,471 pounds of lead, valued in all at $1,985,607, or an average of $56.13 per ton. The bullion from placer operators amounted to $178,430 in gold and 3,843 ounces of silver.

*Bullfrog district.*—The metallic output of the district was valued at $97,791 in 1911, as against an output valued at $467,949 in 1910. The larger part of the tonnage was ore and tailings, aggregating 28,650 tons, treated by cyanidation, which yielded $80,918 in gold and 11,854 ounces of silver, valued in all at $87,201, or an average of $3.04 per ton. There were 360 tons of gold and silver ore shipped directly to the smelter, which included several lots containing copper and lead. The principal production of bullion was made by lessees from the Montgomery Shoshone mine, where some ore was mined and old tailings were re-treated in the mill on the property. Lead ore, containing a small quantity of copper, was shipped from the Ready Cash mine and siliceous ore from the Diamond Queen property. Other producers were the Tramp-Eclipse and Mayflower Bullfrog properties. The latter is opened by an incline shaft 570 feet deep and has 1,300 feet of drifts. The ore was treated in the 15-stamp mill and cyanide plant equipped for amalgamation, classification, and cyanidation of the coarse sands. The oxidized ores in this property extend to the 500-foot level. In the deepest workings sulphides were encountered.

*Cloverdale district.*—The Orizaba mine was the only producer in 1911, and yielded silver ore carrying gold values.

*Ellendale district.*—Rich gold and silver ores were reported as ipped from this district aggregating 94 tons, which contained 54,702 in gold and 1,823 ounces of silver, valued in all at $55,668, an average of $592.21 per ton.

*Goldyke district.*—One small lot of selected gold and silver ore was ipped from the Contact group, which is developed by 2 shafts, the eepest of which is 160 feet. Altogether the property has 2,000 feet drifts.

*Johnnie district.*—The Johnnie mine was the only producer in the strict and yielded gold and silver ore, which was treated in the mill the property, consisting of 16 Nissen stamps and one 10-foot Lane ill. The mine is 14 miles southeast of Armagosa.

*Lodi Valley and Marble district.*—The July and Climax property, hich is opened by an adit 375 feet long and 50 feet of drifts, produced small quantity of gold and silver ore, part of which was treated in arrastre and the remainder shipped directly to the smelter.

*Manhattan district.*—All of the ore mined in the district, with the ception of 72 tons shipped to the smelter, was treated by amalgaation and cyanidation processes. The total production of the disict aggregated 13,945 tons, which includes 80 tons of tailings, and elded $418,683 in gold and 8,489 ounces of silver, valued in all at 23,182, or an average of $30.35 per ton. Surface and drift placers, orked by hydraulic and dry methods by 26 producers, yielded 36,052 in gold and 2,737 ounces of silver, the total value of which as $137,503. The largest tonnage of ore was mined by lessees from e Big Four property and shipped to the War Eagle mill, where covery of gold and silver was made by amalgamation and cyanidaon processes. Other important productions were made from the hite Caps No. 1 claim, which is developed by an incline shaft 170 et deep and has 350 feet of drifts. Siliceous ore from the Union No. property yielded gold and silver, of which about 60 per cent was ee and the remainder was recovered by cyanidation. This property opened by an incline shaft 270 feet deep. The ore body is a chimey in limestone with small intersecting veinlets. Partly oxidized d sulphide ores were treated from the Union No. 9 claim, which is ened by an incline shaft 385 feet deep. The Earl property proced oxidized ores, which were treated at the War Eagle mill. The roperty is opened by a 250-foot incline shaft and has about 300 feet drifts. The Union Extension is opened by a vertical shaft 85 feet eep. Some oxidized ore was extracted, in which there exist some ase metals. Amalgamation saves about 68 per cent of the gold. wo 50-ton custom mills were in continuous operation during 1911, d a third plant of like capacity, known as the Associated Mill, as under construction. In connection with this mill, a sampling orks is being built with the intention to purchase ore direct from ssees of various mining properties. The leases on mining property Manhattan run from one to three years and the royalties are sually paid on a sliding scale, starting perhaps on a grade of ore alued at $20 per ton, the royalty averaging about 10 per cent of the et returns after milling and hauling charges have been deducted. he principal placer productions were made from the Boston & ustin, Crescent, Gold Wedge, Midford, Nellie Gray, Pedro, Bright ugust No. 1, September, Wolftone Extension, Rainbow, and Cornuopia Fraction.

*Millet district.*—Three properties in Millet district produced 59 tons of ore, yielding $3,461 in gold, 86 ounces of silver, 18 pounds of copper, and 1,052 pounds of lead, valued in all at $3,555, or an average of $60.26 per ton. The Nevada National property at Clear Creek, in West Smoky Valley, was the principal producer of gold and silver bullion, which was extracted from ore treated in the 5-stamp mill on the property. The Korf property yielded lead ore of shipping grade, containing good values in gold and silver and a small quantity of copper.

*Reveille district.*—The Liberty Reveille property, which is opened by a vertical shaft 160 feet deep and an adit 180 feet long, was operated during the year.

*Round Mountain district.*—Fifteen deep mines and 4 placers yielded $429,837 in gold and silver in 1911. All of this production, with the exception of 6 tons shipped to smelters, was treated in amalgamation mills. The ore mined, 51,904 tons, yielded $380,385 in gold and 12,242 ounces of silver, having a total value of $386,873, or an average of $7.45 per ton. The surface placers yielded $42,378 in gold and 1,106 ounces of silver. The total was valued at $42,964. The principal work and production were from the mine and surface workings of the Round Mountain Co. The total development consists of 34,947 feet of drifts, crosscuts, raises, shafts, and tunnels. The mill is equipped with 2 Nissen stamps, 10 Standard stamps, 3 Huntington mills, and 2 tube mills. Amalgamation is used exclusively and the total capacity of the mill is about 200 tons of ore daily. The oxidized ores are reported to extend to the depth of the incline shaft, which is about 900 feet, or about 600 feet below the surface. Other properties that made important productions were the Fairview, with an adit 700 feet long; the Blue Jacket, with 2 vertical shafts 90 feet deep and 400 feet of drifts; and the Daisy, with a vertical shaft 200 feet deep and 700 feet of drifts.

The Round Mountain [1] mine yielded—

54,915 tons of milling ore valued at $389,582.05 for the gold and silver, or an average of $7.09 per ton. A net recovery of $6.24 per ton was made at the amalgamation mill on the property. The saving was $342,996.62, or 88 per cent of the gross value of the ore. Reserve ore in the mine is estimated to be 145,820 tons, which, at $7 per ton, has a total value of $1,020,740. The surface placers of the mine were worked by lessees, and during last year's operations a new vein was uncovered showing a width of approximately 20 feet carrying values in gold and silver from $3 to $12 per ton. The new vein will be developed from the 200-foot level of the No. 2 shaft. This is the second vein uncovered by the placer miners. During the year 7,508.5 feet of development work was performed at an average cost of 90 cents per foot. Nearly one-half of the development work was done on the 700-foot level.

Experience shows that it is necessary to crush the large bowlders to release the values, followed by screening out the waste. In view of this fact, and the large tonnage available, a crushing and screening plant is being installed on the 450-foot level similar in design to Crushing Plant No. 2 in the Stringer Section of the mine, which has given excellent results. The plant consists of a 12 by 20 jaw crusher, 18-inch belt conveyor to carry the crushed material to a 10-foot by 40-inch revolving screen, which is set above loading pockets cut out above the level. The fines will be trammed to the shaft, hoisted, and sent to the mill and the waste material taken to the surface through a haulage way by means of mule train. This haulage way has been completed by driving a tunnel from the surface to connect with the 450 west level.

*Silver Bow district.*—From the Nevada Silver Bow and Catlin claims some silver ore, carrying small values in gold, was shipped to the smelter.

[1] Annual report for year ending Mar. 31, 1912.

*Stonewall district.*—Experimental shipments of silver ore, containing small values in gold, were taken from the Stonewall King group, which is developed by an incline shaft 165 feet deep.

*Tonopah district.*—A notable advance in mining has taken place at Tonopah, which, imbued with new life, is entering upon an era of greater production and prosperity than it has enjoyed in the past. This condition is largely due to the development in the Belmont mine, which is said to have over 700,000 tons of paying ore developed to a depth of 1,400 feet, practically proving up a new Tonopah 2,000 feet east of the original discovery; and the Tonopah Extension mine is proving the continuance of the ore zone on its westward trend. The paying ore zone of Tonopah is said to have been proved for a total length, on its easterly-westerly course, for over 7,000 feet, and for a width of 3,500 feet north and south, to a greatest depth of 1,400 feet in the Belmont mine. In both the extreme eastern and western workings, the veins are of great extent, being from 30 to 60 feet wide, and of the same width in the deepest levels. The following mills were operated in 1911: Tonopah Mining, 100 stamps; Belmont, 60 stamps; Montana, 40 stamps; Tonopah Extension, 30 stamps; and West End, 20 stamps. The last three named were put in operation in November. Milling facilities are now being increased by the erection of a 10-stamp mill by the McNamara Mining Co., and also by the new 60-stamp mill of the Belmont, which is expected to be in operation in June, 1912. At Liberty, 25 miles north of Tonopah, the Liberty mill and mine were operated, but temporarily closed down to effect changes in the process of treating the ores.

The table which follows shows the production in the Tonopah district in 1910 and 1911:

*Mine production of gold, silver, copper, and lead in Tonopah district, Nye County, Nev., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 111,441.58 | $2,303,702 | 114,479.19 | $2,366,495 | +3,037.61 | +$62,793 |
| Silver.....do.... | 10,422,869 | 5,628,349 | 10,868,268 | 5,760,182 | + 445,399 | +131,833 |
| Copper.....pounds.. | 942 | 120 | ..... | ..... | − 942 | − 120 |
| Lead.....do.... | 6,902 | 304 | ..... | ..... | − 6,902 | − 304 |
| Total..... | ..... | 7,932,475 | ..... | 8,126,677 | ..... | +194,202 |

Nineteen mines in 1911 produced 404,375 tons of ore, yielding gold and silver valued at $8,126,677, or an average recovery of $20.10 per ton. In 1910 18 mines produced 365,139 tons of ore, which was valued at $7,932,475, or an average of $21.72 per ton. The yield in 1909 aggregated 278,743 tons, containing metals valued at $5,494,600, with an average of $19.71 per ton. The largest part of the ore, or 368,274 tons, was treated at cyanide plants with and without concentration, yielding $1,509,823 in gold, 6,361,241 ounces of silver, and 2,808 tons of concentrates, containing $314,402 in gold and 1,938,186 ounces of silver. The average recovery value of the ores and 1,323 tons of tailings cyanided was $13.21 per ton, and the average value of the concentrate was $477.80 per ton. Crude ores

of shipping grade, amounting to 34,778 tons, contained $542,270 in gold and 2,568,841 ounces of silver, valued in all at $1,903,756, or an average of $54.74 per ton.

The statistics showing the gold and silver production from the Tonopah district from 1902 to 1911, inclusive, are given in the table following:

*Mine production of gold and silver in Tonopah district, Nye County, Nev., from 1902 to 1911, inclusive, in fine ounces.*

| Year. | Gold. | | Silver. | | Total value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| 1902 | 26,462.58 | $547,030 | 2,434,453 | $1,217,241 | $1,764,271 |
| 1903 | 25,297.61 | 522,948 | 2,404,180 | 1,274,215 | 1,797,163 |
| 1904 | 18,703.03 | 386,626 | 2,115,191 | 1,205,659 | 1,592,285 |
| 1905 | 58,356.99 | 1,206,346 | 5,369,439 | 3,243,141 | 4,449,487 |
| 1906 | 63,113.75 | 1,304,677 | 5,697,928 | 3,817,612 | 5,122,289 |
| 1907 | 57,250.36 | 1,183,470 | 5,330,398 | 3,518,063 | 4,701,533 |
| 1908 | 78,584.75 | 1,624,491 | 7,172,396 | 3,801,370 | 5,425,861 |
| 1909 | 67,742.46 | 1,400,361 | 7,872,967 | 4,093,943 | 5,494,304 |
| 1910 | 111,441.58 | 2,303,702 | 10,422,869 | 5,628,349 | 7,932,051 |
| 1911 | 114,479.19 | 2,366,495 | 10,868,268 | 5,760,182 | 8,126,677 |
| Total | 621,432.30 | 12,846,146 | 59,688,089 | 33,559,775 | 46,405,921 |

The net earnings of the Belmont [1] mine and mill during the fiscal year were $1,802,080, as compared with $1,502,381 for the previous year. The operating expenses of the fiscal year, compared with the previous three years, are as follows:

| | 1912 | 1911 | 1910 | 1909 |
|---|---|---|---|---|
| Mining expenses | $377,585.25 | $322,766.41 | $177,784.93 | $174,761.34 |
| Depreciation of mining equipment | 15,028.44 | 15,028.44 | 15,028.44 | 15,028.44 |
| Development work | 167,832.37 | 160,369.60 | 94,672.30 | 107,427.93 |
| Total | 560,446.06 | 498,164.45 | 287,485.67 | 297,217.71 |
| Dry tons of ore mined | 115,563 | 81,066 | 36,930 | 37,994 |
| Cost per ton, including depreciation and development | $4.85 | $6.14½ | $7.784 | $7.815 |
| Tons of ore and waste mined | 188,988 | 97,304 | 69,160 | 77,234 |

The operating expenses of the Belmont mill, including indirect expenses (but not depreciation), for the fiscal year were $293,840.13, as compared with $239,568.95 for the previous year. The cost per dry ton milled, including indirect expenses (but not depreciation), compared with the previous three years, is as follows:

| | 1912 | 1911 (10 months). | 1910 (8 months). | 1909 |
|---|---|---|---|---|
| Dry tons of ore milled | 87,349 | 58,624 | a 37,166 | 61,929 |
| Cost per dry ton milled | $3.364 | $4.086 | $4.057 | $4.379 |

a Includes custom ore.

The average actual extraction at the mill during the past year was 92.54 per cent of the gross values, as compared with 89.4 per cent in 1911, 89.9 per cent in 1910, and 86.2 per cent in 1909.

[1] Annual report to stockholders for year ending Feb. 29, 1912.

The average value of the ore produced during the year, as compared with the previous two years, is as follows:

| | 1912 | 1911 | 1910 |
|---|---|---|---|
| Tons shipped to mill | 87,952 | 59,159 | 29,898 |
| Average gross value per ton | $20.84 | $27.58 | $14.40 |
| Tons shipped to smelters | 27,611 | 21,907 | 7,032 |
| Average gross value per ton | $61.35 | $54.76 | $34.89 |
| Total production (dry tons) | 115,563 | 81,066 | 36,930 |
| Average gross value per ton | $30.51 | $34.93 | $17.99 |

The sales of ore, bullion, concentrates, etc., for the year were divided as follows:

| | |
|---|---|
| Gold, 45,069 ounces (average $19.68 per ounce), sold for | $886,971.47 |
| Silver, 4,535,762 ounces (average 52.5 cents per ounce), sold for | 2,381,542.54 |
| | 3,268,514.01 |
| Less treatment charges, assaying, freight, and express | 387,337.26 |
| Total receipts | 2,881,176.75 |

Rapid development of the Belmont vein ore body to a degree consistent with that hoped for became impossible owing to high mine temperatures and poor ventilation and, more serious than this, to the flow of water encountered below the twelfth level that greatly retarded deep development, and more especially the sinking of the Belmont shaft. These adverse conditions, however, were overcome as expeditiously as was consistent with economy, and the Belmont ore body has been proven as to its probable full length on two levels (the tenth and the eleventh) and in part to its upper boundaries, and to such an extent throughout the exposed area that a fairly accurate estimate of the factor of width may be arrived at. * * * The ore reserves in the property consist of 348,912 tons of positive ore, of 247,907 tons of probable ore, and of 109,263 tons of possible ore, or a total of 706,082. * * * Timbering costs are excessive. * * * The cost of the sinking of the Belmont shaft has added largely to the per ton cost. This work, especially below the twelfth level, has been very costly, as has also been the sinking of the development winzes. The heavy flow of water encountered at a point about 25 feet below the level and the great head, 1,300 feet, against which this water has to be pumped out of the mine, necessitated a heavy type of mine pump. We are at present pumping an average of 52 gallons per minute. The mine water is pure and warm and will be used, in part at least, in the new mill. * * * During the fiscal year ending February 29, 1912, the mill has been in continuous operation, treating during the period 87,349 dry tons of ore averaging 0.269 ounce of gold and 28.26 ounces of silver, or $20.84 per ton. The total precious metal content of the tonnage milled was 23,470.17 ounces gold and 2,468,249.48 ounces silver, of a gross value of $1,820,946.64. The total recovered values from the milling operation amounted to 22,066.39 ounces gold and 2,259,650.96 ounces silver, or $1,665,966.97, being a recovery of 92.54 per cent. There were recovered by concentration in the 651 tons of concentrates produced 5,377.09 ounces of gold and 580,709.55 ounces of silver, or 22.01 per cent of the total gold content and 23.53 per cent of the total silver content, a combined gold and silver recovery by concentration of 23.36 per cent. The cyanide treatment produced 16,689.30 ounces gold and 1,678,941.41 ounces of silver, or 71.11 per cent of the total gold content and 68.02 per cent of the total silver content, a combined gold and silver recovery by cyanidation of 68.87 per cent. In the cyanidation treatment, 24,839 tons, or 28.43 per cent, of sand were treated by the leaching process, the tailings from which sands averaged 0.0274 ounce gold and 3.707 ounces silver, or $2.542 per ton, the extraction on the sands from mill heads to sand tails being 87.60 per cent. There were 61,862 tons, or 70.82 per cent, of slimes treated by the agitation process, and the tailings from these slimes averaged 0.0116 ounce gold and 1.867 ounces silver (a total of $1.236 per ton), the extraction on the slimes from mill head to slime tails being 94 per cent. The value of fine grinding, through the agency of the two tube mills installed during the preceding year, having been conclusively proven by the increased extraction results of the slimed and agitated ore, as compared with the extraction results of the coarser sands treated by leaching, the problem of sliming and agitating the greatest possible proportion of ore became of prime importance.

This problem, in a mill designed for treatment of equal parts of sands and slimes, has been overcome with almost no outlay by the change of the slime agitation system from the cycle system to the continuous system, thus increasing the agitating capacity of the plant from 61.62 per cent of its total capacity, as of last year, to 70.82 per cent of the total capacity this year. * * * The average extraction for the year (92.54 per cent) has been raised from that of the preceding year (89.03 per cent) by 3.51 per cent.

The average number of stamps dropping through the year was 56.6 or 94.33 per cent of the total possible. The direct milling cost per ton for the period was $3.13, a saving of the similar cost of $3.713 of last year of $0.583 per ton. The direct and indirect milling cost per ton was $3.879, a reduction of $0.701 per ton over the previous year's direct and indirect cost of $4.58 per ton. A gross saving of $1.424 per ton, made up a lowered mill operating cost of $0.701 per ton and an increased extraction of $0.723 over the previous year, has been made, amounting to $124,384.97. * * *

The project of a new cyanide mill at the mine, to take the place of the old mill at Millers, was authorized in June, 1911, when it had become evident that the ore reserves fully warranted this large item of new construction. Ground for the new plant was broken in July, and by the end of that month the work of excavating was well under way. * * * Briefly, the new milling plant will consist of a crushing department, the mill proper, a separate refinery, transformer house, boiler house, storeroom and assay office, with other small auxiliary buildings, tanks, etc. * * * The new mill will obviate entirely the shipment of ore to the smelters, and will also allow the extraction and reduction of ores of a grade lower than are under present conditions profitable. * * *

While the freight and treatment on mill ore to the Millers' plant averages at present but $4.619 ($3.879 treatment plus 70 cents freight, plus 4 cents toll over Montana spur) on $20 ore, it is to be considered that on all ore shipped to mill and smelter the freight and treatment charge (average for year) is greatly higher, $6.449 per ton. The new mill should save on a tonnage of ore equal to that shipped during the past year (114,960 tons) $287,400, and should save in the first year of operation (on say 165,000 tons treated), $412,500.

During the year there were milled and treated from the property of the Tonopah Mining Co.[1] 174,685 dry tons of ore, averaging 0.286 ounce of gold and 26.05 ounces of silver, or $19.97 per ton, which is 0.034 ounce of gold and 2.60 ounces of silver, or $2.01 per ton lower than the average of the ore milled during the previous year, when silver averaged $0.424 per ounce lower. The total contents of the ore milled were 49,796 ounces of gold and 4,550,199 ounces of silver, with a gross value of $3,503,255.21, from which there were recovered by concentration and shipped to the smeltery 1,290 dry tons of concentrates, averaging 4.962 ounces of gold and 696.66 ounces of silver per ton, with a total content of 6,400.101 ounces of gold and 898,509.82 ounces of silver, and a smelter gross value of $589,349.56. The cyanide treatment yielded in bullion 3,379,-712.66 troy ounces, containing 38,493.312 fine ounces of gold and 3,217,601.61 fine ounces of silver, with a smelter gross value of $2,545,557.07. The slag and refinery by-products shipped to smeltery amounted to 86 dry tons, averaging 0.832 ounce of gold and 54.72 ounces of silver per ton, with a total content of 71.741 ounces of gold and 4,720.18 ounces of silver, of a gross value of $3,848.98.

The cost of marketing products, including freight, treatment, sampling, and express on bullion, concentrates and slag, amounted to $81,203.25, or 46.5 cents per ton of ore milled, a decrease of 5.1 cents per ton compared with the cost of the previous year. This is owing to a lower value of concentrates, the smaller quantity of products produced, and a recent cut of $1.50 per $1,000 valuation in the express rate on bullion. * * *

The percentage of recovery by concentration, cyanidation, and combined extraction shows the recovery by concentration to have been 12.75 per cent of the gold and 19.75 per cent of the silver contents of the ore. The recovery by cyanidation was 77.5 per cent of the gold and 70.81 per cent of the silver contents of the ore, giving a combined extraction by concentration and cyanidation of 90.25 per cent of the gold and 90.56 per cent of the silver, total 90.56 per cent of the contents of the ore. The combined recovery for the previous year was 90.13 per cent of the gold, and 92.40 per cent of the silver; total gold and silver recovery 92.40 per cent of the ore contents. * * *

[1] Annual report for year ending Feb. 29, 1912.

The average cost to mine and mill the ore and market the products for the past year was as follows (excluding extraordinary work):

| | |
|---|---|
| Mining costs | $3.71 |
| Milling costs | 2.74 |
| Metal losses in milling | 1.89 |
| Freight on ore milled | .72 |
| Marketing mill products | .57 |
| Cost per ton | 9.63 |
| Profit per ton | 10.34 |
| Average gross value of ore milled | 19.97 |

Dividends paid since April 22, 1905, ranged from 25 to 40 per cent on the capitalization, and with the dividend of $400,000 declared April 20, 1912, aggregated $8,850,000.

Throughout the year 1910–11 both mine and mill of the Montana-Tonopah Mining Co.[1] were operated continuously and a steady production maintained.

In the mine the amount of development work done, together with diamond drilling, compares closely with the amount for 1909–10, while the tonnage of ore produced exceeds that of the previous year by 1,847 tons.

The following table shows a comparison of the year's results with that of the preceding year:

| | 1910–11 | Per ton. | 1909–10 | Per ton. |
|---|---|---|---|---|
| Tons mined and milled | 52,092.20 | | 50,245.00 | |
| Gross value per ton of ore produced during the year | | $14.57 | | $15.22 |
| Net value of ore produced during the year | $659,912.26 | $12.66 | $650,405.11 | $12.94 |
| Total expenditure | $488,830.79 | $9.38 | $515,689.71 | $10.26 |
| Total profits from ore | $171,081.47 | $3.28 | $134,715.40 | $2.68 |
| Development footage—feet | 9,932 | | 10,681 | |
| Diamond drilling—feet | 1,086½ | | None. | |

The mill crushed 52,092.20 tons, operating a total of 359⅔ days, with an average stamp duty of 3.7 tons. As compared with the previous year, the results are as follows:

| | 1910–11 | 1909–10 |
|---|---|---|
| Average value of ore—per ton | $14.57 | $15.22 |
| Average value of tailing—do | $1.35 | $1.43 |
| Extraction—per cent | 90.7 | 90.8 |

Average price of silver for the year was 53.55 cents per ounce.

Shipments of concentrate and bullion during the year were as follows: 882.092 tons of concentrate, gross value per ton, $303.66; estimated net value, $248,382.81; 39,028 pounds of bullion, average fineness, gold 12.31, silver 910.36; estimated net value, $413,050.50.

Ore was mined from 365 feet below the surface to the fifth level.

In making a statement of ore reserves it is exceedingly difficult to arrive at any accurate estimate. This is borne out by the fact that a year ago an amount of 26,000 tons was given as a reasonable estimate of the available ore in the mine, whereas 52,092 tons have been produced since that time. In a district such as this, where the veins are so irregular and broken and faulting so intense, anything but a mere approximation of the amount of available ore in the mine is out of the question. It is reasonably safe, however, to consider that at the present time there are 19,000 tons of ore available for stoping. Two dividends were paid, aggregating $120,000, during the year.

There were mined and milled at the Tonopah Extension[2] property during the year 50,900.49 tons of ore, containing 848,407.86 ounces

[1] Annual report for year ending Aug. 31, 1911. [2] Annual report for year ending Mar. 31, 1912.

of silver and 9,011.807 ounces of gold, or an average of 16.667 ounces of silver and 0.177 ounce of gold per ton.

The average fineness of the bullion was 930.75 for the silver and 10.31 for the gold. The cost of marketing bullion was reduced to $0.227 per ton of ore treated, which is $0.264 less than the previous year. This is due to discontinuing all concentration in the mill and the total recovery being done by cyanidation, thereby putting all the recovered values in the form of bullion, which naturally costs less to market than values contained in concentrate. * * *

The cost per ton of ore for mining and milling and marketing the bullion produced was as follows:

| | |
|---|---|
| Mining costs (including all development work) | $4.725 |
| Milling costs | 3.247 |
| Metal losses in milling | 1.200 |
| Marketing bullion—express, $0.067; refining, $0.160 | .227 |
| Total cost per ton | 9.399 |
| Profit per ton | 3.401 |
| Gross value of ore milled | 12.800 |

The ore mined during the year came from stopes both east and west of the shaft on the 270-foot, 400-foot, 500-foot, and 600-foot levels and from stopes west of the shaft on the 660-foot level.

The West End [1] mine yielded 1,151 tons of shipping ore, with a gross average value of $33.06 per ton in gold and silver, on which the freight and treatment costs amounted to $10.25 per ton, giving a net return of $22.81 per ton.

The milling ore aggregated 15,903 tons and averaged $16.75 per ton in gold and silver, on which the milling costs, including loss in milling and marketing bullion, were $6.80. The net returns on this ore were $9.96 per ton. At the time the mill was purchased the tailing dump was also secured from the Tonopah Mining Co. These tailings were worked through the old Midway mill several years ago, it having been the intention of the company to work these tailings mixed with higher grade ore from the mine. When the mill was first started this was done, and from 1,828 tons, averaging $8.70 in gold and silver, $2.30 in gold and silver was recovered.

*Tybo or Hot Creek district.*—Sulphide copper ore, carrying considerable silver values, a little gold, and some lead and zinc, was mined from the Ophir property, which is opened by a vertical shaft 100 feet deep and has about 700 feet of drifts. The company has a 10-stamp mill 4 miles from the property, but it was not used in 1911.

*Union district.*—Gold bullion and concentrates, containing gold and silver values with a little copper and lead, were produced at the Berlin property, which is opened by an incline shaft 850 feet deep. The 30-stamp mill on the property is equipped with vanners. The property was operated from January until in April.

### ORMSBY COUNTY.

The principal source of the metal output was the treatment of tailings from the old mills erected along Carson River during the early Comstock mining. A small quantity of amalgam, carrying silver and small quantities of gold, was recovered from the tailings by lessees and owners of the mills. A test lot of gold and silver ore was run through a 3-stamp prospecting mill on the Athens property in the Washoe and Eagle Valley district. Copper ore of shipping grade was produced in the Delaware district from the Nevada Dela-

[1] Annual report for year ending Mar. 31, 1912.

ware mine, which is developed by a shaft 108 feet deep. It is reported that the oxidized ore extends to the lower level, which is 275 feet deep and is reached by one of the adits. A small production of gold and silver bullion was made by one placer operator. It is presumed that the bullion recovered was from the early mill operations along Carson River.

STOREY COUNTY.

*Mine production of gold, silver, copper, and lead in Storey County, Nev., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 24,325.03 | $502,843 | 47,279.26 | $977,349 | +22,954.23 | +$474,506 |
| Silver.....do.... | 320,716 | 173,187 | 618,006 | 327,543 | + 297,290 | + 154,356 |
| Copper.....pounds.. | 573 | 73 | ..... | ..... | − 573 | − 73 |
| Lead.....do.... | 1,871 | 82 | ..... | ..... | − 1,871 | − 82 |
| Total..... | ..... | 676,185 | ..... | 1,304,892 | ..... | + 628,707 |

The ore mined aggregated 95,894 tons by 34 producers in 1911. This is 12,698 tons less than was mined in 1910 by 26 producers. However, the total average value of the ore, which contained gold and silver only, increased from $6.23 in 1910 to $13.61 in 1911. The larger part of the production, or 89,799 tons, was treated by amalgamation and cyanidation processes, with a total gold and silver recovery value of $278,357, from this ore and 1,275 tons of old tailings. At the gold and silver mills 1,287 tons of concentrates were produced, yielding $473,685 in gold and 307,188 ounces of silver, in all valued at $636,495, or an average of $494.55 per ton. Ore of shipping grade aggregated 4,820 tons and contained $278,520 in gold and 210,417 ounces of silver, valued in all at $390,041, or an average of $80.92 per ton. A better grade of ore was mined than in either of the two previous years, as shown by the average value per ton, which, in 1910, was $6.23 and in 1909 was $8.88 per ton. The Ophir Silver Mining Co.[1] mined 14,000 tons of ore, which was concentrated at the Kinkead mill, having an average recovery value per ton of $21.99 in gold and $8.63 in silver, or a total value of $428,745. Since October, 1903, there had been mined to December 20, 1911, ore aggregating 96,203 tons, with a gross value in gold and silver of $3,143,491, or a gross average of $32.67 per ton. There was an average recovery of 83.19 per cent of the gross value of the metals. Ore was mined from the 2,100-foot level and each level below it to the 2,500-foot level, where the company took up the work of the south drift, which had been driven to the north boundary line of the property by the Mexican Mining Co., following the ore vein and extending it 339 feet.

WASHOE COUNTY.

Production was reported from 34 mines in 1911, against 17 in 1910. The yield of ore aggregated 3,983 tons, which was 311 tons greater than in 1910, and the average value per ton increased from $13.18 to

[1] Annual report for year ending Nov. 30, 1911.

$18.59. Most of this value was for gold and silver content, which increased from $12.39 to $18.12. The ore of milling grade, producing gold and silver bullion, aggregated 3,307 tons, treated largely by the amalgamation process, which, with that recovered by cyanidation, was valued at $67,346. Included in this value is the bullion recovered from 600 tons of old tailings. Some of the ores treated at the gold and silver mills yielded concentrate, which aggregated 60 tons, containing gold, silver, and copper. Altogether there were produced at milling plants 77 tons of concentrate, containing $1,531 in gold, 3,201 ounces of silver, 174 pounds of copper, and 27,004 pounds of lead, valued in all at $4,464, or an average of $57.97 per ton. Crude ore shipped directly to smelters aggregated 25 tons, containing $89 in gold, 2,838 ounces of silver, 1,801 pounds of copper, and 9,125 pounds of lead, in all valued at $2,229, or an average of $89.16 per ton.

*Leadville district.*—The Tehoqua, Donnelly Mountain, and White Fox properties produced 795 tons of ore, which yielded $9,707 in gold, 7,206 ounces of silver, 404 pounds of copper, and 36,129 pounds of lead, valued in all at $15,203, or an average of $19.12 per ton. The larger part of this ore, or 730 tons, was milled, producing gold and silver bullion and concentrates, containing most of the lead and some of the copper. The remainder, or 14 tons, was shipped directly to the smelter and contained lead and silver with a small quantity of copper and a trace of gold. The Donnelly Mountain property has a 5-stamp mill, which was erected in July. On account of the lack of water it only operated a short time. The Tehoqua mine is equipped with a 50-ton concentrating mill, in which the sulphide ores produced from the mine in 1911 were treated. The property is opened by a vertical shaft 335 feet deep and has 1,557 feet of drifts and an adit 164 feet long. The White Fox claim was a producer of a trial shipment of silver ore, containing a little copper and gold.

*Wedekind district.*—Ore and old tailings, aggregating 749 tons, were treated in 1911, and contained gold, silver, and copper valued at $4,250, or an average of $5.67 per ton. The tailings of the Wedekind mine made up the principal production and were treated by the cyanide process in a 2-roll Merrill mill having a capacity of about 250 tons daily. The experimental work on these tailings shows that they are too coarse and require regrinding. It is reported that added equipment is being made to treat successfully the remainder of the tailing dump.

*West Comstock district.*—All of the ores produced, amounting to 266 tons, contained gold and silver and were treated at amalgamation mills, yielding an average recovery of $9.63 per ton. The Fink-Mahoney property, which is opened by an adit 690 feet long, was operated for three months of the year, during which time the 5-stamp mill was in commission.

*White Horse district.*—Almost the entire output of the district was treated at milling plants equipped for the amalgamation of the gold and silver contained in the ores. The total output aggregated 2,173 tons, containing $51,502 in gold and 985 ounces of silver, valued in all at $52,024, or an average recovery of $23.94 per ton. Two lots of concentrates, amounting to 21 tons, were produced from this ore, and 1 ton of crude ore was shipped directly to the smelter. Most of the work in the district was performed by lessees. The principal producer was the Keystone. The ores carried principally gold values

and very little silver. The property is opened by an incline shaft 200 feet deep, and it is reported that the oxidized ores extend to a depth of 150 feet. The property is equipped with a Huntington mill and amalgamation plates. Other producers were the Gold Ledge, Renegade, Crown Hill, Jumper Hutchinson, Golden Eagle, and Cabin No. 2.

## WHITE PINE COUNTY.

*Mine production of gold, silver, copper, and lead in White Pine County, Nev., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 22,134.71 | $457,565 | 21,595.03 | $446,409 | − 539.68 | −$11,156 |
| Silver.....do.... | 199,222 | 107,580 | 122,685 | 65,023 | − 76,537 | − 42,557 |
| Copper.....pounds.. | 63,930,278 | 8,119,145 | 67,035,361 | 8,379,420 | +3,105,083 | +260,275 |
| Lead.....do.... | 586,589 | 25,810 | 572,654 | 25,769 | − 13,935 | − 41 |
| Total..... | ..... | 8,710,100 | ..... | 8,916,621 | ..... | +206,521 |

The ore output of White Pine County is the largest in the State, and in 1911 aggregated 2,778,607 tons. The bulk of this ore is mined by steam shovels on one property at Ely, and is concentrated in its mills near by. Reports were made by 25 operators in various districts in 1911, as against 24 reporting in 1910. The total average value of the ore, which was principally for copper value, was $3.21 in 1911, as against $3.64 in 1910. The gold and silver value in this ore decreased from $0.24 in 1910 to $0.18 in 1911. Milling ores, consisting chiefly of low-grade porphyry ore mined by steam shovels, aggregated 2,746,377 tons, of which 2,745,524 tons were sent to concentrating mills, producing 242,134 tons of concentrate, which contained $427,177 in gold, 99,585 ounces of silver, 65,262,838 pounds of copper, and 424 pounds of lead, valued in all at $8,637,832, or an average of $35.67 per ton. The crude smelting ores shipped directly to smelters amounted to 32,080 tons, which yielded $10,808 in gold, 22,910 ounces of silver, 1,772,523 pounds of copper, and 572,230 pounds of lead, valued in all at $270,265, or an average of $8.42 per ton. Ores treated at gold and silver mills, at which the amalgamation process was used, aggregated 853 tons, yielding $8,525 in gold and silver, or an average recovery of $9.99 per ton.

*Cherry Creek district.*—Eight producers mined 61 tons of ore, of which the larger part was shipped to the smelter. The total metallic output of the district contained $1,513 in gold, 2,287 ounces of silver, 410 pounds of copper, 10,138 pounds of lead, valued in all at $3,232 or an average of $52.98 per ton.

*Duck Creek district.*—The output of the district aggregated 239 tons of ore mined by 6 operators who shipped directly to the smelters. The ore contained $113 in gold, 1,831 ounces of silver, 753 pounds of copper, and 214,772 pounds of lead, valued in all at $10,843, or an average of $45.37 per ton. Most of the ore was lead sulphide, carrying silver and small quantities of gold with a little copper. Operators of the Cuba property made one shipment of lead ore. The incline shaft on this property was sunk to a depth of 32 feet, and the adit is 45 feet long. The Lead Queen mine is opened by a vertical

shaft 40 feet deep, and operators shipped 45 per cent lead sulphide ore, which also contained 3 per cent of zinc.

*Eagle district.*—The Red Hills mine was the only producer in the district, producing carbonate lead ore of shipping grade containing silver and a little gold and copper.

*Osceola district.*—The San Pedro and Marble property was the principal producer of gold ore, which contained a little silver. Production was also made from the Exchange property, and a prospect in the district.

*Robinson (Ely) district.*—The following table shows the production of Robinson or Ely district in 1910 and 1911:

*Mine production of gold, silver, copper, and lead in Robinson district, White Pine County, Nev., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 20,473.51 | $423,225 | 21,057.01 | $435,287 | + 583.50 | +$12,062 |
| Silver.....do..... | 108,000 | 58,320 | 104,107 | 55,177 | − 3,893 | − 3,143 |
| Copper.....pounds.. | 63,914,197 | 8,117,103 | 67,033,547 | 8,379,194 | +3,119,350 | +262,091 |
| Lead.....do..... | 180,407 | 7,938 | 10,216 | 460 | − 170,191 | − 7,478 |
| Total..... | ..... | 8,606,586 | ..... | 8,870,118 | ..... | +263,532 |

The largest operations were those of the Nevada Consolidated Copper Co. in the Eureka and Liberty open pits, where mining of the ore was carried on by steam shovels, and in the Veteran shaft (481 feet deep), from which the ore is carried to the surface by hoists. Two classes of ore were mined, the sulphides going to the concentrators and the carbonates directly to the smelter. The Copper Mines Co. and the Ely Calumet were also producers.

According to the annual report of the Nevada Consolidated Copper Co. for the year ending December 31, 1911, which is made to cover fifteen months (the additional three months being due to a change in the fiscal year previously ending September 30), the total profitable ore developed by drifting and that remaining in reserve was estimated on January 1, 1912, to be 40,853,371 tons, with an average copper content of 1.662 per cent.

As in other years, all mining has been done by means of steam shovels, and this work continued to be carried on most satisfactorily. Much the larger portion of the ore mined has been from the Copper Flat or Eureka Pit. * * * The deepest point reached in the Eureka Pit is about 115 feet below the main tracks, or approximately 137 feet below the capping. * * *

In December, after having been idle for over two years, the Veteran section of the Cumberland-Ely was restarted and a small amount of ore was mined underground.

During the 15 months period the following dry tons of sulphide ore was mined and shipped to the concentrator:

| | Tons. | Per cent of copper. |
|---|---|---|
| Eureka pit..... | 3,261,482 | 1.790 |
| Liberty pit..... | 62,956 | 1.768 |
| Veteran mine..... | 5,584 | 3.050 |
| Total..... | 3,330,022 | 1.791 |

The ore mined was of lower grade than for the year preceding, due to the fact that more ore was taken from the fringes of the deposit, from greater depth and from sections which had previously been considered as waste, but with the reduced cost of concentration, were found to be profitable.

During the year siliceous carborate ore amounting to 205,795 dry tons, averaging 2.91 per cent copper, was mined, of which 39,235 tons were crushed and delivered to the smelter and 166,560 tons were put into mine storage. * * *

Including charges of every description, such as labor, supplies, repairs, management, taxes, proportion of general and New York expenses, etc., the mining costs have averaged 15.7 cents per dry ton. An additional charge of 15 cents per ton of ore has been made to cover stripping redemption on the Eureka ore body and 22 cents per ton on the Liberty ore body. * * * Stripping costs have been reduced to 36.30 cents per cubic yard. The cost for mining carbonate ore has been 74.40 cents per wet ton, the increase being largely due to more care being necessary in sorting. * * *

The Steptoe Valley plant has been worked very successfully during the past year and has shown considerable increase in capacity. Greater efficiency and a decrease in the cost of operating have resulted. A great reduction has been made in the cost of concentration, amounting to 15.9 cents or 25.72 per cent. This is due in the main to treating a larger tonnage of ore per section. * * *

The results for the fiscal period (15 months) were as follows:

| | |
|---|---|
| Tons of ore treated (dry) | 3,338,242 |
| Average copper assay.....per cent.. | 1.80 |
| Percentage of extraction (copper) | 67.59 |
| Ratio of concentration | 11.34 |
| Assay value in gold.....ounces.. | .013 |
| Assay value in silver.....do.... | .079 |
| Percentage of extraction (gold) | 52.72 |
| Percentage of extraction (silver) | 45.92 |
| Average gold and silver recovered per ton ore.....cents.. | 17.35 |
| Average copper in concentrates.....per cent.. | 13.80 |

The yield from all ore mined and treated and from siliceous carbonate ore delivered to the smelter has amounted for the 15 months to 78,541,270 pounds of copper.

The total cost per pound of copper has been 7.17 cents, and deducting miscellaneous earnings but including fund to cover improvements and depreciation this is reduced to 6.79 cents. These costs include all possible charges, such as costs in Nevada, shipping, refining, marketing, legal expenses, taxes, New York expenses, etc.

The Giroux[1] property contains two distinct classes of ore deposits: (1) The disseminated ore deposits, known as the "porphyry ores," lying at comparatively shallow depths, and (2) the lime-porphyry contact fissure vein deposits, or deep ores.

The property covers a total area of about 2,000 acres, having an extreme length east and west of 15,000 feet, on the strike of the mineralized zone, by a width of 4,000 feet, north and south, at about its widest point. The property covers in its central portion a laccolith or uplift of plutonic rocks at one of its widest points in the Ely districts. The outlying or outer fringe of mining claims of the property covers the zone of contact between the sedimentary rock series, which are paleozoic limestones, and the plutonic or eruptive rock series commonly known as porphyry. This contact occurs along the entire southern boundary of the property.

The dip of the sedimentary rocks at all points of contact is away from a common center. The junction of the eruptive rock series with the sedimentaries is a mining geological condition recognized as favorable for ore deposition, and this property exhibits one of the most extensive croppings of quartz material, accompanied with iron in its different oxidized forms, also bodies of copper (principally carbonates) lying exposed on the surface. * * *

The general system of careful development that is being carried on by churn drilling in the zone of, and in, the disseminated or concentrating ore bodies is being supplemented by the company in the comprehensive development of the new Giroux deep shaft, and by drifting in the contact fissure zone, in which the Alpha mine occurs.

The Alpha shaft on the Giroux property is over 1,400 feet deep, and prior to sinking it the extent of the water likely to be encountered was unknown. The work on the 1,200-foot and 1,400-foot

[1] Annual report for year ending Dec. 31, 1911.

levels has shown the existence of large quantities of water, which is being pumped at the rate of a million gallons per day. This water will be used for the concentrator, situated at Kimberly. The plant has a maximum capacity of 500 tons of crude ores daily, and was operated by the former management in 1908 and 1909, since which time it has been idle. The small smelting plant which the company formerly had was destroyed in 1908. Instead of rehabilitating the concentration plant a favorable contract was made with the Steptoe Co. to concentrate and smelt the ores delivered to it from the Giroux property.

*Shoshone district.*—The St. Lawrence was the only producer in the district. The property is opened by a series of 5 tunnels on the vein, making levels 100 feet apart.

*Ward district.*—The Argus mine was a producer of some silver ore carrying quantities of lead and copper. Some old tailings were re-treated from the property and yielded concentrates containing silver only.

## NEW MEXICO.[1]

By Charles W. Henderson.

### PRODUCTION.

The value of the production of gold, silver, copper, lead, and zinc in New Mexico for 1911, as reported from 105 productive mines, 20 of which were placers, amounted to $2,704,843. As compared with $2,691,080 in 1910, this shows an increase in value for 1911 of $13,763. The gold yield was 36,900.84 fine ounces, valued at $762,808, an increase in 1911 of 13,563.58 fine ounces in quantity and of $280,384 in value. The silver yield was 1,354,540 fine ounces, an increase of 510,553 fine ounces in quantity and of $262,153 in value. The copper output was 4,057,040 pounds, a decrease in 1911 of 557,346 pounds; the lead output was 2,966,222 pounds, a decrease of 1,354,619 pounds; and the zinc output was 10,237,176 pounds, a decrease of 7,850,953 pounds. The value of the base metals showed a decrease of $78,897 for copper, $56,637 for lead, and $393,240 for zinc.

There were 232,699 short tons of ore sold or treated in 1911, which averaged $11.54 in value per ton, as compared with 191,865 short tons, averaging $13.89 per ton in 1910; with 164,156 short tons, averaging $12.48 in 1909; with 135,434 tons, averaging $11.09 in 1908; and with 219,992 tons, averaging $14.64 in 1907. The output of siliceous or dry ore, of copper ores, and of copper-lead ores increased; the output of lead, zinc, and lead-zinc ores decreased; and the total output increased 40,834 tons. The average recovered value per ton in 1911 in gold and silver was $9.70 in siliceous ore, $1.70 in copper ores, $3.65 in lead ores, $6.48 in copper-lead ores, and $1.18 in lead-zinc ores.

During 1911 there were treated in amalgamating or cyaniding mills in New Mexico 109,113 tons of ore, and the bullion saved amounted to $452,592 in gold, an average value per ton of $4.147, and 771,014 ounces of silver, valued at $408,637, an average recovery

[1] Lindgren, W., Graton, L. C., and Gordon, C. H., The ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910.

per ton of 7.066 ounces and an average value of $3.745, the value in gold and silver being $861,229, an average value per ton of $7.89. The recovery as bullion per ton of ore treated in 1910 was $4.38 in gold and $3.31 in silver, a total of $7.69, showing for 1911 an average increase of $0.20 per ton in gold and silver recovered as bullion.

From 59,622 tons treated at mills by concentration or magnetic separation there were produced 16,243 tons of concentrates (ratio 3.671 to 1[1]), valued at $164,108 in gold, an average per ton of $10.10, and 333,654 ounces of silver, valued at $176,837, an average per ton of $10.89, the value in gold and silver being $340,945, with an average of $20.99 per ton. For those concentrates which carried copper (however little) the average assay (dry) was 6.75 per cent; for those concentrates which carried lead the average assay (dry) was 13.91 per cent; for zinc concentrates the average assay of zinc content was 40 per cent.

From the 168,735 tons crushed in all classes of mills there were produced $616,700 in gold from both bullion and concentrates, at an average recovery of $3.65 per ton, and $585,474 in silver, at an average recovery of $3.47 per ton, a recovery in both gold and silver of $1,202,174 at an average of $7.12 per ton in these two metals for all ore milled. The average value in gold and silver recovered in 1910 from 128,527 tons milled was $5.82 per ton, an increase for 1911 of $1.30 per ton; the average in 1909 from 112,612 tons milled was $2.86, an increase for 1911 over 1909 of $4.26 per ton.

Crude ore shipped to smelters amounted to 63,964 short tons, containing $127,394 in gold, averaging $1.99 (or 0.096 ounce) per ton; 249,710 ounces of silver, valued at $132,346, averaging 3.90 ounces, or $2.07 per ton, the value in both gold and silver being $259,740, and the average per ton $4.06 as compared with $2.59 in 1910. Crude ore to smelters also contained 2,931,113 pounds of copper, averaging 2.29 per cent, and 1,403,454 pounds of lead, averaging 1.10 per cent. Much of this ore carried neither copper nor lead; that which carried copper averaged 2.83 per cent of that metal; that which carried lead averaged 9.68 per cent; that which carried zinc averaged 33.37 per cent.

*Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 23,337.26 | $482,424 | 36,900.84 | $762,808 | +13,563.58 | +$280,384 |
| Silver.....do.... | 843,987 | 455,753 | 1,354,540 | 717,906 | + 510,553 | + 262,153 |
| Copper.....pounds.. | 4,614,386 | 586,027 | 4,057,040 | 507,130 | − 557,346 | − 78,897 |
| Lead.....do.... | 4,320,841 | 190,117 | 2,966,222 | 133,480 | −1,354,619 | − 56,637 |
| Zinc.....do.... | 18,088,129 | 976,759 | 10,237,176 | 583,519 | −7,850,953 | − 393,240 |
| Total..... | ..... | 2,691,080 | ..... | 2,704,843 | ..... | + 13,763 |

[1] The ratio of the tonnage of the product from magnetic separating mills, as compared with the tonnage treated, is lower than in wet-milling practice.

*Tonnage of ore sold or treated, number of deep mines producing, by counties, and average value per ton of ore mined in New Mexico in 1910 and 1911.*

| County. | Short tons of ore sold or treated. | | Number of deep mines producing. | |
|---|---|---|---|---|
| | 1911 | Increase (+) or decrease (−). | 1910 | 1911 |
| Bernalillo | | − 24 | 1 | |
| Colfax | 2,306 | + 2,213 | 2 | 3 |
| Dona Ana | 5 | + 3 | 1 | 2 |
| Grant | 93,770 | + [a] 24,888 | 39 | 42 |
| Lincoln | 1,578 | − 9,149 | 6 | 3 |
| Luna | 229 | − 296 | 9 | 8 |
| Otero | 1,096 | − 1,449 | 6 | 6 |
| Sandoval | 10 | + 10 | | 1 |
| Santa Fe | 120 | − 4,619 | 4 | 3 |
| Sierra | 5,036 | − 3,270 | 6 | 7 |
| Socorro | 128,549 | + [a] 32,527 | 11 | 10 |
| Total | 232,699 | + 40,834 | 85 | 85 |
| Average value per ton | | | $13.89 | $11.54 |

[a] Tonnage of zinc ore in Grant and Socorro counties combined in 1910, to conceal individual production.

## GOLD.

The gold production for New Mexico in 1911 amounted to 36,900.84 fine ounces, valued at $762,808, as against 23,337.26 fine ounces, valued at $482,424, in 1910, an increase of 13,563.58 fine ounces in quantity and of $280,384, in value. Socorro County alone produced 25,844.49 fine ounces, valued at $534,253, or 70 per cent of the total gold yield. This was almost entirely from the siliceous ore mines at Mogollon. There were also increased gold yields in Colfax, Grant, Luna, and Sierra counties, chiefly from siliceous and copper ores. Siliceous ore furnished in the whole State 33,035.23 fine ounces, valued at $682,899, or 89.52 per cent of the total; copper ores contained 2,920.69 fine ounces of gold, valued at $60,376, or 7.91 per cent of the total, chiefly from Grant County. Placer gold amounted to 905.29 fine ounces, valued at $18,714, or 2.5 per cent of the total. The gold in lead, copper-lead, and lead-zinc ores was negligible.

*Source of gold production in New Mexico, by kinds of ore, in 1911, by counties, in fine ounces.*

| County. | Placer mines. | Deep mines. | | | | | Total. |
|---|---|---|---|---|---|---|---|
| | | Dry or siliceous ore. | Copper ores. | Lead ores. | Copper-lead ore. | Lead-zinc ores. | |
| Colfax | 476.98 | 1,526.09 | | | | | 2,003.07 |
| Grant | 195.58 | 2,616.28 | 2,812.37 | | 1.01 | | 5,625.24 |
| Lincoln | 78.80 | 1,466.01 | | | | | 1,544.81 |
| Luna | | | | 5.03 | | | 5.03 |
| Otero | | 324.98 | | | | | 324.98 |
| Santa Fe | 114.12 | 11.51 | 36.00 | | 16.58 | | 178.21 |
| Sierra | 39.81 | 1,242.97 | 61.32 | | | | 1,344.10 |
| Socorro | | 25,816.48 | 11.00 | 3.01 | | 14.00 | 25,844.49 |
| Unapportioned | | 30.91 | | | | | 30.91 |
| Total, 1911 | 905.29 | 33,035.23 | 2,920.69 | 8.04 | 17.59 | 14.00 | 36,900.84 |
| Total, 1910 | 1,262.30 | 20,578.63 | 1,449.41 | 12.38 | 2.52 | 32.02 | 23,337.26 |
| Increase (+) or decrease (−) | −357.01 | +12,456.60 | +1,471.28 | −4.34 | +15.07 | −18.02 | +13,563.58 |

## SILVER.

The silver yield in 1911 amounted to 1,354,540 fine ounces, valued at $717,906, as compared with 843,987 fine ounces, valued at $455,753, in 1910, an increase for 1911 of 510,553 fine ounces in quantity and of $262,153 in value. Of the total, Socorro County produced 1,109,945 fine ounces, or 82 per cent, chiefly from siliceous ore from the Mogollon district. Grant County furnished 221,882 fine ounces, or 16 per cent of the total, chiefly from siliceous, copper, and lead ores, with a small quantity from copper-lead ores and placers. The yield of silver from Grant and Socorro counties combined was 98 per cent of the total.

Siliceous ores, chiefly from Grant, Sierra, and Socorro counties, furnished 1,183,265 fine ounces of silver, or 87.36 per cent of the total; copper ores, chiefly from Grant County, furnished 108,892 ounces, or 8.04 per cent; lead ores, chiefly from Grant and Socorro counties, furnished 21,537 ounces, or 1.59 per cent; copper-lead ores, chiefly from Grant and Santa Fe counties, furnished 4,814 ounces, or 0.36 per cent; and lead-zinc ores, from Socorro County, furnished 35,870 ounces, or 2.65 per cent of the total.

*Source of silver production in New Mexico, by kinds of ore, in 1911, by counties, in fine ounces.*

| County. | Placer mines. | Deep mines. | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|
| | | Dry or siliceous ore. | Copper ores. | Lead ores. | Zinc ores. | Copper-lead ores. | Lead-zinc ores. | |
| Colfax | 77 | 1,177 | | | | | | 1,254 |
| Dona Ana | | | | 11 | | 100 | | 111 |
| Grant | 70 | 98,515 | 107,144 | 13,424 | | 2,729 | | 221,882 |
| Lincoln | 5 | 109 | | | | 70 | | 184 |
| Luna | | 8 | 195 | 1,075 | | | | 1,278 |
| Otero | | 680 | 35 | | | | | 715 |
| Sandoval | | | 46 | | | | | 46 |
| Santa Fe | 6 | 1 | 710 | | | 1,915 | | 2,632 |
| Sierra | 4 | 15,872 | 487 | 124 | | | | 16,487 |
| Socorro | | 1,066,897 | 275 | 6,903 | | | 35,870 | 1,109,945 |
| Unapportioned | | 6 | | | | | | 6 |
| Total, 1911 | 162 | 1,183,265 | 108,892 | 21,537 | | 4,814 | 35,870 | 1,354,540 |
| Total, 1910 | 374 | 708,762 | 60,228 | 19,040 | 15 | 1,018 | 54,550 | 843,987 |
| Increase (+) or decrease (−) | −212 | +474,503 | +48,664 | +2,497 | −15 | +3,796 | −18,680 | +510,553 |

## COPPER.

In 1911 the copper output of New Mexico amounted to 4,057,040 pounds, valued at $507,130, a decrease of 557,346 pounds as compared with the output of 1910, and a decrease of 1,336,106 pounds as compared with the yield in 1909. Grant County, chiefly from the Central district (near Fierro, Hanover, and Santa Rita) and the Lordsburg district, produced 3,918,928 pounds in 1911, or nearly 97 per cent of the total. The output from Grant County was 485,466 pounds less than in 1910. Other decreases were in Otero and Socorro counties. Santa Fe County, which ranked second to Grant County in yield of copper in 1907, with no copper output in 1908, and with a very small yield in 1909 and in 1910, yielded 16,644 pounds, an increase, as compared with 1910, of 11,494 pounds. Socorro County's

copper output was 79,321 pounds, chiefly from selected lots of crude ore, and from a small content of copper in lead ore and lead concentrates from the lead-zinc ores of the Magdalena district.

True copper ores (containing over 2.5 per cent of copper by dry assay) of Grant, Luna, Otero, Sandoval, Santa Fe, Sierra, and Socorro counties furnished 3,240,693 pounds, or 79.88 per cent of the total; siliceous or dry ore (chiefly from the siliceous ore of Lordsburg district, Grant County) furnished 697,634 pounds, or 17.20 per cent; lead ores, chiefly from the Central and San Simon districts, Grant County, and the Magdalena district, Socorro County, yielded 15,487 pounds, or 0 38 per cent. The lead-zinc mines of Magdalena, Socorro County, contained 66,898 pounds, or 1 65 per cent; and copper-lead ores, chiefly from Grant County, furnished 36,328 pounds, or 0.90 per cent of the total.

There were 2,931,113 pounds of copper contained in crude ore shipped to smelters, representing 72 per cent of the total; concentrates carried 1,125,927 pounds, or 28 per cent.

The Chino Copper Co., with a large acreage of mineral land, at Santa Rita, Grant County, had in operation one section (of 1,000 tons capacity a day) of its mill at Hurley during November and December, 1911, milling in excess of 700 tons a day, and started a second section in December, and a third early in 1912, with two more sections (a total capacity of 5,000 tons a day) in course of construction.

The first quarterly report of the company, covering the period from May 1, 1911, to January 1, 1912, says in part:

> The total quantity of ore developed up to October 1, when drilling ceased, was 54,970,646 tons, having a grade of 2.24 per cent copper. Of this quantity something over 32,000,000 tons lie above the level, to which we will mine by steam shovels.

*Source of copper production in New Mexico, by kinds of ore, in 1911, by counties, in pounds.*

| County. | Dry or siliceous ore. | Copper ores. | Lead ores. | Copper-lead ores. | Lead-zinc ores. | Total. |
|---|---|---|---|---|---|---|
| Colfax | 5,587 | | | | | 5,587 |
| Dona Ana | | | | 353 | | 353 |
| Grant | 679,114 | 3,205,513 | 3,375 | 30,926 | | 3,918,928 |
| Lincoln | | | | 555 | | 555 |
| Luna | 48 | 216 | 1,550 | | | 1,814 |
| Otero | 10,406 | 12,324 | | | | 22,730 |
| Sandoval | | 5,734 | | | | 5,734 |
| Santa Fe | | 12,150 | | 4,494 | | 16,644 |
| Sierra | 1,721 | 3,641 | 12 | | | 5,374 |
| Socorro | 758 | 1,115 | 10,550 | | 66,898 | 79,321 |
| Total | 697,634 | 3,240,693 | 15,487 | 36,328 | 66,898 | 4,057,040 |

## LEAD.

Lead production decreased from 4,320,841 pounds in 1910 to 2,966,222 pounds in 1911. The total output in 1911 was valued at $133,480.

The greatest yield was from the Magdalena district, Socorro County. Socorro County produced 2,124,901 pounds; Luna County, from the Cooks and Victorio districts, yielded 98,888 pounds; Santa Fe County yielded 11,178 pounds; Grant County, 694,247 pounds; and Sierra County, chiefly from the Tierra Blanca district, yielded 28,088 pounds.

Concentrates produced in 1911 contained 1,562,768 pounds of lead, and crude ore sent to smelters contained 1,403,454 pounds.

Lead ores furnished 1,213,014 pounds of lead, and lead-zinc ores, 1,557,093 pounds, the combined contents representing 93 39 per cent of the lead production. Copper-lead ores yielded 5 15 per cent and siliceous ore yielded slightly more than 1 per cent of the total.

*Source of lead production in New Mexico, by kinds of ore, in 1911, by counties, in pounds.*

| County. | Dry or siliceous ore. | Copper ores. | Lead ores. | Copper-lead ores. | Lead-zinc ores. | Total. |
|---|---|---|---|---|---|---|
| Dona Ana | ..... | ..... | 674 | 887 | ..... | 1,561 |
| Grant | 8,660 | 4,846 | 546,591 | 134,150 | ..... | 694,247 |
| Lincoln | ..... | ..... | ..... | 6,620 | ..... | 6,620 |
| Luna | 67 | ..... | 98,821 | ..... | ..... | 98,888 |
| Otero | 739 | ..... | ..... | ..... | ..... | 739 |
| Santa Fe | ..... | ..... | ..... | 11,178 | ..... | 11,178 |
| Sierra | 27,037 | 69 | 982 | ..... | ..... | 28,088 |
| Socorro | 1,862 | ..... | 565,946 | ..... | 1,557,093 | 2,124,901 |
| Total | 38,365 | 4,915 | 1,213,014 | 152,835 | 1,557,093 | 2,966,222 |

## ZINC.

The total recoverable zinc, whether marketed as spelter or oxide, from crude ore and concentrates (or separation products) figured in terms of spelter and zinc in zinc oxide, shipped from New Mexico mines in 1911, was 10,237,176 pounds, valued at $583,519. In 1910 the output was 18,088,129 pounds, valued at $976,759. In terms of marketable metal, the value of the zinc contained in ore from New Mexico in 1911 was $76,389 more than the copper yield and $179,289 less than the gold output.

Mines producing zinc in New Mexico are at Kelly, Socorro County, and in Pinos Altos and Central districts, Grant County.

The ore from the Grant County mines is mostly shipped crude, that from Socorro County is in part shipped crude and in part separated magnetically and by wet milling.

*Source of zinc production in New Mexico, by kinds of ore, in 1911, by counties, in pounds.*

| County. | Zinc ores. | Lead-zinc ores. | Total. |
|---|---|---|---|
| Grant | 306,895 | ..... | 306,895 |
| Socorro | 1,897,134 | 8,033,147 | 9,930,281 |
| Total | 2,204,029 | 8,033,147 | 10,237,176 |

## SMELTERS.

The bulk of the smelting lead and copper ores and concentrates continued to be shipped to the El Paso (Tex.) smelter and to the Copper Queen smelter at Douglas, Ariz. Copper ore was also shipped to the Shannon smelter, Clifton, Ariz. All zinc ore and concentrates were shipped out of the State. None of the smelters within the State were operated.

## MINING INDUSTRY IN NEW MEXICO IN 1911.

In 1911, in point of value of output, the gold and silver production each outvalued that of copper, lead, or zinc. Copper and zinc in 1910 each had an output of greater gross value than either gold of silver, but for 1911 gold and silver production increased materially while copper fell off somewhat and zinc decreased considerably.

The most important district in New Mexico in the output of the precious metals is the Mogollon district, Socorro County. The output for 1911 was 1¾ times that of 1910. The adaptation of concentration and sliming, with cyanide as the solvent, has solved the problem of treating ores averaging (in 1911 in terms of recovered metal) 0.2515 ounce, or $5.20 in gold per ton, and 10.44 ounces, or $5.53 in silver, at a distance of 80 miles from a railroad. There were 4 operating mills in this region in 1911. White Oaks, Lincoln County, is an important gold district, the ore being found in auriferous pyritic quartz veins. The gold has been recovered by amalgamation and cyanidation, but in 1911, the lessened output was from amalgamation alone, the plan being to change the cyanidation process from leaching to agitation. The Elizabethtown district, Colfax County, once an important mining center in New Mexico, again entered the producing stage, through the reopening of three old mines and mills, the cyanide process being used in addition to the amalgamating plates formerly used. The primary gold deposits of the Elizabethtown district are of two types, quartz-pyrite veins and contact-metamorphic deposits in calcareous sediments (the former having produced much the greater portion of the gold). Placers in this district also made a small increase in gold output. Heavily increased shipments of siliceous gold and silver bearing copper and dry ores from the fissure veins of Lordsburg increased materially the yield from this district. Basic oxidized ores of gold and copper of the Jarilla district, near Oro Grande, Otero County, yielded an increased gold output, but the cessation of placer operations caused a decrease for the district. The base ores of the Las Animas district, near Hillsboro, chiefly sulphides of copper carrying gold and silver with some free gold, yielded an increased output of gold, and the shipment of manganese ore carrying silver and lead from the dump of the Lake Valley Mines Co. yielded an appreciable quantity of silver. Lead-zinc ores from Magdalena furnished some silver.

Copper has always been an important metal in New Mexico, the recorded output from 1845 to 1910 having been 92,323,163 pounds.[1] For 1912 and for many years to come copper alone will no doubt surpass in value the present metallic output of New Mexico, through the operations of the Chino Copper Co., at Santa Rita. This company, mining with steam shovels, was operating in December, 1911, one section of 1,000 tons capacity a day of its proposed 5,000-ton mill, and early in 1912 was operating three sections, with the prospect of having five sections operating before the end of the year. The company reports 54,970,646 tons of ore carrying 2.24 per cent of copper developed. The copper output from Lordsburg, Grant County, was 1½ times that of 1910. Much development of copper ores was done in the Burro Mountain district, Grant County. The reopening of the

[1] Butler, B. S., Mineral Resources U. S. for 1910, pt. I, 1911, p. 204.

mines and smelter of the Santa Fe Gold & Copper Co. at San Pedro, Santa Fe County, is in prospect.

The output of lead again decreased. The lead mines of the Organ district, Dona Ana County, were again idle. The production of lead and lead-zinc ores of the Magdalena district, Socorro County, was less than in 1910.

The zinc output, chiefly from the Central district, Grant County, and from the Magdalena district, Socorro County, decreased in both districts. The Tri-Bullion Smelting & Development Co., at Kelly, Magdalena district, operated steadily its magnetic and wet mills (capacity of both combined 1,800 tons a month), but a decreased tonnage was shipped by lessees from the upper levels of the Kelly mine of this company. Carbonate lead and zinc ores were shipped from the Graphic and the Juanita mines.

A 50-ton concentrating plant for the treatment of zinc sulphide was built and tested at the Cleveland mine, Pinos Altos, Grant County, and prospecting and developing of zinc carbonate ores on this property were continued.

The following table shows the production of gold, silver, copper, lead, and zinc in New Mexico in 1911, by counties:

*Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1911, by counties.*

| County. | Tonnage. | Gold.[a] | | Silver.[a] | |
|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. |
| | *Short tons.* | *Fine ounces.* | | *Fine ounces.* | |
| Colfax | 2,306 | 2,003.07 | $41,407 | 1,254 | $665 |
| Dona Ana | 5 | | | 111 | 59 |
| Grant | 93,770 | 5,625.24 | 116,284 | 221,882 | 117,597 |
| Lincoln | 1,578 | 1,544.81 | 31,934 | 184 | 98 |
| Luna | 229 | 5.03 | 104 | 1,278 | 677 |
| Otero | 1,096 | 324.98 | 6,718 | 715 | 379 |
| Sandoval | 10 | | | 46 | 24 |
| Santa Fe | 120 | 178.21 | 3,684 | 2,632 | 1,395 |
| Sierra | 5,036 | 1,344.10 | 27,785 | 16,487 | 8,738 |
| Socorro | 128,549 | 25,844.49 | 534,253 | 1,109,945 | 588,271 |
| Unapportioned | | 30.91 | 639 | 6 | 3 |
| Total | 232,699 | 36,900.84 | 762,808 | 1,354,540 | 717,906 |

| County. | Copper. | | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | *Pounds.* | | |
| Colfax | 5,587 | $698 | | | | | $42,770 |
| Dona Ana | 353 | 44 | 1,561 | $70 | | | 173 |
| Grant | 3,918,928 | 489,866 | 694,247 | 31,241 | 306,895 | $17,493 | 772,481 |
| Lincoln | 555 | 69 | 6,620 | 298 | | | 32,399 |
| Luna | 1,814 | 227 | 98,888 | 4,450 | | | 5,458 |
| Otero | 22,730 | 2,841 | 739 | 33 | | | 9,971 |
| Sandoval | 5,734 | 717 | | | | | 741 |
| Santa Fe | 16,644 | 2,081 | 11,178 | 503 | | | 7,663 |
| Sierra | 5,374 | 672 | 28,088 | 1,264 | | | 38,459 |
| Socorro | 79,321 | 9,915 | 2,124,901 | 95,621 | 9,930,281 | 566,026 | 1,794,086 |
| Unapportioned | | | | | | | 642 |
| Total | 4,057,040 | 507,130 | 2,966,222 | 133,480 | 10,237,176 | 583,519 | 2,704,843 |

[a] Includes placer production.

## REDUCTION MILLS IN NEW MEXICO IN 1911.

The following is a list of the reduction mills in New Mexico:

*List of reduction mills in New Mexico, by counties.*

COLFAX COUNTY.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| | | | | *Short tons.* |
| Aztec | Elizabethtown | Amalgamation, concentration, cyanidation. | 40 stamps, Wilfley tables. | 160 |
| Raton Mining and Milling Co. | do | Amalgamation | 15 stamps | 60 |
| Red Bandana-Moreno | do | Amalgamation, cyanidation. | 5-foot Huntington mill | 20 |

GRANT COUNTY.

| | | | | |
|---|---|---|---|---|
| Burro Mountain [a] | Burro Mountain | Concentration | | 250 |
| Chino Copper Co.[b] | Central | do | Rolls, Chilean mills, various classifiers, Garfield tables, Isbell vanners. | 5,000 |
| Cleveland | Pinos Altos | do | Rolls, screens, Richards classifier, jigs, and Wilfley tables. | 50 |
| American Exploration Co.[c] | Steeple Rock | Cyanidation | 10 stamps | 8 |

LINCOLN COUNTY.

| | | | | |
|---|---|---|---|---|
| Wisconsin | Jicarilla | Amalgamation and concentration. | Elpass mill | 50 |
| Parsons [d] | Nogal | Amalgamation | Huntington mill | 100 |
| Old Abe | White Oaks | Amalgamation and cyanidation of tailings. | 20 stamps | 80 |
| Wild Cat | do | Amalgamation and cyanidation.[e] | 10 stamps | 50 |

OTERO COUNTY.

| | | | | |
|---|---|---|---|---|
| Tularosa | Tularosa | Concentration | Crusher, coarse rolls, second rolls, Huntington mill on tailings from first roughing tables. | 100 |

SANTA FE COUNTY.

| | | | | |
|---|---|---|---|---|
| Boston-New Mexico [f] | Los Cerrillos | Concentration | | 200 |
| Sunset [g] | do | do | | 100 |
| San Lazarus [h] | San Pedro | Amalgamation | 6-foot Huntington mill. | 25 |

[a] Idle in 1911.
[b] See Min. & Sci. Press, Mar. 30, 1912, pp. 464–466.
[c] Completed early in 1912.
[d] Closed October, 1910.
[e] Amalgamation only, 1911.
[f] Idle in 1911; operated in 1910.
[g] Completed in 1911.
[h] Short run only.

*List of reduction mills in New Mexico, by counties*—Continued.

SIERRA COUNTY.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| | | | | *Short tons.* |
| U. S. Treasury [a] | Black Range | Concentration and cyanidation. | Blanket concentrator, filter press, 4 Dorr thickeners. | 50 |
| Black Range [b] | At Fairview | Amalgamation, concentration, cyanidation. | Stamps, amalgamating plates, tube mill, concentrating tables, cyanide plant. | 50 |
| Ocean Wave [c] | Hermosa | Concentration | Crusher, 20 stamps (750 pounds) 4 Wilfley tables, 2 Wilfley slimers. | 50 |
| Empire [c] | Las Animas | Amalgamation and concentration. | 20 stamps, Wilfley tables. | 50 |
| Ready Pay [d] | do | do | 2 Huntington mills, plates, 2 Wilfley tables. | 30 |
| Statehood [e] | do | do | Wilfley tables | 100 |

SOCORRO COUNTY.

| | | | | |
|---|---|---|---|---|
| Deadwood | Mogollon | Concentration and cyanidation. | 15 stamps, Wilfley tables, Bayliss classifier, Dorr classifier, sand tanks, agitator, Portland continuous filter, De La Vergne interval combustion oil engine. | 75 |
| Enterprise [c] | do | Cyanidation | Sturtevant rolls, agitation, Kelly filter press. | 50 |
| Ernestine | do | Concentration and cyanidation. | 30 stamps, 5 Standard concentrating tables, 2 Dorr classifiers, agitation tanks, De La Vergne crude-oil engines. | 110 |
| Socorro Mines | do | do | 30 stamps, concentration, sliming in tube mills and filtration of agitation pulp in Burt filter press, 2 Dorr classifiers, 4 Dorr thickeners. | 165 |
| Treasure | do | do | 20 stamps, Wilfley tables, Akin classifier, settlers, leaching vats, etc. | 80 |
| Mistletoe [f] | Magdalena | Dry concentration | Sutton, Steele & Steele dry tables. | 50 |
| Ozark [g] (Graphic) | do | Experimental flotation. | | |
| Tri-Bullion | do | Magnetic separation and wet concentration. | 8 Traylor tables, 2 Deister slime tables, 4 Dean magnetic separators. | 1,800 |

TAOS COUNTY.

| | | | | |
|---|---|---|---|---|
| Eureka [h] | Rio Hondo | | 10 stamps | 50 |

[a] Completed Jan. 6, 1912.
[b] Undergoing changes.
[c] Idle in 1911; operated in 1910.
[d] Idle in 1911.
[e] Operated 1911.
[f] Idle in 1911; operated experimentally in 1910.
[g] Idle in 1911; operated experimentally in 1910. New mill in prospect.
[h] Erected in 1911.

*Tonnage of ore to gold and silver mills and concentrating mills, with quantity of gold and silver in bullion produced in New Mexico in 1911, by counties.*

| County. | Ore to gold and silver mills. | | | Ore to concentrating mills. |
|---|---|---|---|---|
| | Quantity. | Gold in bullion. | Silver in bullion. | |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Short tons.* |
| Colfax | 2,306 | 1,328.92 | 558 | ..... |
| Grant | ..... | ..... | ..... | 42,985 |
| Lincoln | 1,570 | 1,466.01 | 109 | ..... |
| Otero | ..... | ..... | ..... | 304 |
| Santa Fe | 14 | 11.50 | 1 | ..... |
| Sierra | 2,550 | 1,167.87 | 707 | ..... |
| Socorro | 102,673 | 17,888.93 | 769,633 | 16,333 |
| Unapportioned | ..... | 30.91 | 6 | ..... |
| Total | 109,113 | 21,894.14 | 771,014 | 59,622 |

*Mine production of gold, silver, copper, lead, and zinc from New Mexico concentrates in 1911, by counties.*

| County. | Concentrates produced. | | | | | |
|---|---|---|---|---|---|---|
| | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Colfax | 72 | 197.17 | 619 | 5,587 | ..... | ..... |
| Grant | 2,725 | 1.00 | 2,087 | 1,050,846 | 3,391 | ..... |
| Otero | 19 | ..... | 27 | 7,897 | ..... | ..... |
| Sierra | 52 | 59.00 | 641 | 1,616 | 422 | ..... |
| Socorro | 13,375 | 7,681.53 | 330,280 | 59,981 | 1,558,955 | 5,304,000 |
| Total | 16,243 | 7,938.70 | 333,654 | 1,125,927 | 1,562,768 | 5,304,000 |

*Mine production of gold, silver, copper, lead, and zinc from New Mexico crude ore shipped to smelters in 1911, by counties.*

| County. | Crude ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Dona Ana | 5 | ..... | 111 | 353 | 1,561 | ..... |
| Grant | 50,785 | 5,428.66 | 219,725 | 2,868,082 | 690,856 | 306,895 |
| Lincoln | 8 | ..... | 70 | 555 | 6,620 | ..... |
| Luna | 229 | 5.03 | 1,278 | 1,814 | 98,888 | ..... |
| Otero | 792 | 324.98 | 688 | 14,833 | 739 | ..... |
| Sandoval | 10 | ..... | 46 | 5,734 | ..... | ..... |
| Santa Fe | 106 | 52.59 | 2,625 | 16,644 | 11,178 | ..... |
| Sierra | 2,486 | 77.42 | 15,135 | 3,758 | 27,666 | ..... |
| Socorro | 9,543 | 274.03 | 10,032 | 19,340 | 565,946 | 4,626,281 |
| Total | 63,964 | 6,162.71 | 249,710 | 2,931,113 | 1,403,454 | 4,933,176 |

*Tonnage of ore to gold and silver mills, with quantity of gold and silver contained in bullion produced in New Mexico in 1911, by processes.*

| Quantity. | Process. | Gold in bullion. | Silver in bullion. |
|---|---|---|---|
| *Short tons.* | | *Fine ounces.* | *Fine ounces.* |
| 109,113 | Amalgamation | 3,972.57 | 1,406 |
| | Cyanidation | 17,921.57 | 769,608 |
| 109,113 | ..... | 21,894.14 | 771,014 |

*Consumption of quicksilver and cyanide in New Mexico mills in 1911.*

| Quicksilver. | Potassium cyanide. | Sodium cyanide. |
|---|---|---|
| Quantity. | Quantity. | Quantity. |
| *Pounds.* 220 [a] | *Pounds.* 71,870 | *Pounds.* 93,526 |

[a] Represents 1 pound of quicksilver for every 18.06 ounces of gold; or, 1 ounce of quicksilver for every 1.13 ounces of gold.

*Subdivision of tonnage of ore sold or treated in New Mexico in 1911, by counties, in short tons.*

| County. | Dry or siliceous ore. | Copper ores. | Lead ores. | Zinc ores. | Copper-lead ores. | Lead-zinc ores. | Total. |
|---|---|---|---|---|---|---|---|
| Colfax | 2,306 | ..... | ..... | ..... | ..... | ..... | 2,306 |
| Dona Ana | ..... | ..... | 1 | ..... | 4 | ..... | 5 |
| Grant | 22,663 | 68,876 | 1,338 | 506 | 387 | ..... | 93,770 |
| Lincoln | 1,570 | ..... | ..... | ..... | 8 | ..... | 1,578 |
| Luna | 2 | 4 | 223 | ..... | ..... | ..... | 229 |
| Otero | 770 | 326 | ..... | ..... | ..... | ..... | 1,096 |
| Sandoval | ..... | 10 | ..... | ..... | ..... | ..... | 10 |
| Santa Fe | 14 | 55 | ..... | ..... | 51 | ..... | 120 |
| Sierra | 5,006 | 28 | 2 | ..... | ..... | ..... | 5,036 |
| Socorro | 102,703 | 6 | 1,611 | 7,896 | ..... | 16,333 | 128,549 |
| Total, 1911 | [a] 135,034 | 69,305 | 3,175 | 8,402 | 450 | 16,333 | 232,699 |
| Total, 1910 | 86,917 | 55,220 | 4,084 | 20,944 | 15 | 24,685 | 191,865 |
| Increase (+) or decrease (−) | +48,117 | +14,085 | −909 | −12,542 | +435 | −8,352 | +40,834 |

[a] Includes 7,853 tons gold ore; 3,151 tons silver ore; 124,030 tons gold and silver ore. The greater part of this tonnage is mixed sulphide and oxide, the proportion being unobtainable.

## REVIEW BY COUNTIES.

### BERNALILLO COUNTY.

No ore was marketed from Bernalillo County in 1911. Development work was done in the Hell Canyon and Soda Springs districts. In the Soda Springs district lead sulphide ore has been developed and shipments are in prospect for 1912 from the Octoroon and Swastika Mountain Top properties.

### COLFAX COUNTY.[1]

*Elizabethtown district.*—This district continued to be the principal producing placer district in New Mexico with a yield of $9,860 in placer gold in 1911, as compared with $9,588 in 1910, with $16,037 in 1909, and with $11,274 in 1908.

The reopening of three lode mines near Baldy and the use of cyanidation in addition to amalgamation in the mills resulted in a material output of gold bullion and also a gold-silver-copper concentrate. The principal lode mine was the Aztec, the total production from which is estimated as between $1,250,000 and $1,500,000, of which about $1,000,000 was taken out in the first four years after its discovery in 1868.[2] The plant consists of a 40-stamp amalgamating

[1] Graton, L. C., The ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, pp. 91–108.
[2] Idem, p. 97.

mill with Wilfley tables. In 1911 tailings were treated with cyanide. The Raton Mining & Milling Co. operated its Mountain Witch claim and sent some oxidized ore to its 15-stamp amalgamating mill. Lessees on the Red Bandana-Moreno claims sent oxidized ore to the 5-foot Huntington mill, with cyanide tanks on the property. Experiments were made on ore from the Ajax mine.

### DONA ANA COUNTY.

*Organ Mountains district.*[1]—A trial lot of copper-lead-silver ore was shipped from the Orejon claim of the Aztec Copper Co. Much development work was done on the Memphis mine, opening up shoots of copper and zinc carrying silver, with the prospect of shipping in 1912. Development work was done on the Philadelphia mine and on the Homestake mine.

### GRANT COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Grant County, N. Mex., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 3,189.46 | $65,932 | 5,625.24 | $116,284 | +2,435.78 | +$50,352 |
| Silver.....do.... | 156,557 | 84,541 | 221,882 | 117,597 | + 65,325 | + 33,056 |
| Copper.....pounds.. | 4,404,394 | 559,358 | 3,918,928 | 489,866 | − 485,466 | − 69,492 |
| Lead.....do.... | 257,953 | 11,350 | 694,247 | 31,241 | + 436,294 | + 19,891 |
| Total..... | ..... | 721,181 | ..... | 754,988 | ..... | + 33,807 |
| Zinc.....pounds.. | (a) | (a) | 306,895 | 17,493 | Decrease. | Decrease. |
| Total..... | (a) | (a) | ..... | 772,481 | ..... | Increase. |

[a] Included with Socorro County.

Grant County again ranked second to Socorro County both in quantity of ore sold or treated and in value of the product. There was an increased output from this county in 1911 in gold, silver, and lead, but a decrease in copper and zinc. In production of copper, however, Grant County maintained first rank, with nearly 97 per cent of the total output. The yield of zinc in Grant County decreased because of the idleness of the mines of the Empire Zinc Co. at Hanover. There were 42 deep mines producing in Grant County in 1911, as compared with 39 in 1910, and with 50 in 1909.

The yield from placers in the Pinos Altos district showed a small increase.

Production of siliceous and dry ores (carrying copper under 2.5 per cent) amounted to 22,663 short tons, as compared with 15,831 tons in 1910, and with 7,884 tons in 1909. Copper ores formed the bulk of the tonnage with 68,876 tons, an increase of 16,389 tons. The remainder consisted of lead, zinc, and copper-lead ores.

As in 1910, over one-half of the entire tonnage mined, amounting in 1911 to 50,785 tons, was shipped crude to smelters. The average assay per ton of smelting ore was 0.107 ounce in gold and 4.33 ounces

[1] Lindgren, W., The ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, pp. 205–213.

in silver. The average assay of that ore which carried copper was 2.91 per cent copper, and of that which carried lead was 15.63 per cent lead.

From the 42,985 tons concentrated were produced 2,725 tons of concentrates (ratio 16 to 1), the average assay per ton of which was 19.28 per cent in copper.

*Apache No. 2 district.*—There was no production from the Apache No. 2 district in 1911.

*Burro Mountain district.*—The Burro Mountain district, southwest of Silver City, near Leopold and Tyrone, produces chiefly copper, with small quantities of gold and silver. The output in 1911 was valued at a little more than half that of 1910, which was also greatly under the 1909 yield. Light development work was carried on by the Burro Mountain Copper Co. The shaft was sunk an additional 100 feet and 3,000 feet of drifts were run. Copper ore was shipped from the Savanna and Casino mines. The Chemung Copper Co. continued active development of its chalcocite ores in porphyry—this development having been continuous since May, 1906. The workings on this property consist of 3 vertical shafts, respectively 532 feet, 722 feet, and 421 feet deep, and 1 incline shaft 200 feet deep. The total underground development in addition to the shafts was 55,552 feet, of which 11,643 feet were driven in 1911. Work on the properties of the Mangus and Ocala Cos., stopped in 1910, was not resumed.

*Central district.*—The output of the Central district, embracing the towns of Bayard, Fierro, Georgetown, Hanover, and Santa Rita, was 45,584 tons, yielding $104 in gold, 8,673 fine ounces of silver, 1,413,189 pounds of copper, 605,978 pounds of lead, and 290,122 pounds of zinc, with a total value of $325,156, as compared with $409,955 in 1910. In point of value of production Central district took second place to Lordsburg district, the latter making an increased yield in 1911. However, Central district will no doubt resume first place in rank of districts in Grant County in 1912, when the plant of the Chino Copper Co. will be operating continuously. There were 8 producing mines in this district. Copper ore was shipped from the Hanover group of the Copper Queen Consolidated Mining Co. Lead ore was shipped from the Lucky Bill and Pewabic mines. Zinc ore was shipped from the Pewabic and Mountain Hope group. Lessees on the Georgetown mines treated the ore with jigs, making a lead concentrate, carrying also copper, lead, and vanadium, no payment being received for the last metal from the lead smelter.

The Chino Copper Co. started one section (1,000 tons capacity) of its 5,000-ton mill on October 19, 1911, and the second section on December 28, 1911. A third section was started in April, 1912, and two more sections are being built. Stripping was continued throughout the year.[1] Concentrates were shipped to El Paso. Lessees also shipped some crude copper ore.

The first quarterly report of the Chino Copper Co., dated February 14, 1912, covering the period from May 1, 1911, to January 1, 1912, says:

> Drilling for the purpose of ore development was discontinued about the end of September * * *. Enough ore had been developed to provide for over 30 years for the full capacity of the mill then and now under construction. At the close of de-

[1] For description of previous operations, see Mineral Resources U. S. for 1910, pt. 1, U. S. Geol. Survey, 1911, p. 546.

velopment drilling, 466 drill holes had been completed to an average depth of 386 feet. * * * The total quantity of ore developed up to October 1, when drilling ceased, was 54,970,646 tons, having a grade of 2.24 per cent. Of this quantity something over 32,000,000 tons lie above the level to which we will mine by steam shovels. * * *

The location and initial capacity of the mill under construction were fully described in our previous report, about which date it was decided to increase the plant by the addition of two sections, making five in all, the increase in capacity being from 3,000 to 5,000 tons per day. * * * The first section was completed and put in operation about the middle of October, but did not begin running regularly until November 1. The second section was completed late in December and put in operation about the 1st of January. The third section is now nearing completion and should go into commission before the end of February. * * * One of the additional sections should go into commission in May and the other about the 1st of July, thus completing the plant to a capacity of 5,000 tons per day. * * *

During the months of November and December (1911) the first section, being the only one running during that period, was operated at a rate slightly in excess of 700 tons per day. As is indicated in our discussion of conditions at the mine, the ore delivered to the plant during this period contained a large quantity of its copper contents in oxidized form, and as a consequence the mill extractions were low, * * *. For the month of December the recovery was approximately 30 pounds of copper per ton, and the cost of producing copper with all expenses of every nature included was less than 8.3 cents per pound.

The Santa Rita district was probably the first district in the West from which important copper production was made, the output beginning in the closing years of the eighteenth century and the metal going to Mexico for coinage. There are no accurate records of the production for this early period of operation, but from the best sources available it is estimated that the total production to the close of 1910 has been approximately 103,000,000 pounds.[1]

*Production of copper in the Central district, Grant County, N. Mex., from 1904 to 1911.*

| | Pounds. | | Pounds. |
|---|---|---|---|
| 1904 | 3,264,208 | 1908 | 3,994,502 |
| 1905 | 2,704,233 | 1909 | 3,348,808 |
| 1906 | 3,075,001 | 1910 | 2,679,630 |
| 1907 | 4,994,575 | 1911 | 1,413,189 |

*Chloride Flat district (near Silver City).*—Lead-silver ore was shipped from the Chloride Flat district from the Grand Central mine, and dry oxidized ore, carrying lead and silver, from the Tight-Squeeze mine.

*Eureka district (Hachita,[2] including Sylvanite[3]).*—Lead and copper ores were shipped from the Copper Dick mine, and lead ore from the Dugout mine, of the Eureka district. From Sylvanite, a car was shipped from the Buckhorn group, and a test lot from the Hard-scrabble mine.

*Fleming district.*—Silver-lead sulphide ore, carrying also zinc just over the penalty limit, was shipped from the Golconda mine of the Fleming district.

*Fremont district.*—Assessment work was done on the Eagle mine, in the Fremont district, near the boundary lines of Luna and Grant counties and Mexico.

*Lordsburg district (including Pyramid and Virginia, or Shakespeare districts)*[4].—The Lordsburg district was the first district in point of output for 1911.

[1] Butler, B. S., Copper: Mineral Resources U. S. for 1910, U. S. Geol. Survey, pt. 1, 1911, p. 205.
[2] Lindgren, W., Prof. Paper U. S. Geol. Survey No. 68, 1910, pp. 338-343.
[3] Hill, J. M., idem, pp. 335-338.
[4] Graton, L. C., idem, pp. 332-335.

*Production of gold, silver, copper, and lead in the Lordsburg district, Grant County, N. Mex., 1904–1911.*

| Year. | Tonnage. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1904 | 250 | 58.44 | 2,580 | 18,200 | 12,000 | $5,482 |
| 1905 | 366 | .48 | 7,584 | 48,000 | ..... | 12,079 |
| 1906 | 1,743 | 250.00 | 27,261 | 212,601 | ..... | 64,465 |
| 1907 | 5,645 | 423.81 | 31,303 | 463,335 | 10,522 | 122,646 |
| 1908 | 7,532 | 513.60 | 9,889 | 259,079 | 11,363 | 50,534 |
| 1909 | 10,690 | 1,256.93 | 50,154 | 589,969 | 8,862 | 129,140 |
| 1910 | 29,220 | 2,892.73 | 130,324 | 1,627,591 | 19,662 | 337,742 |
| 1911 | 46,139 | 5,159.10 | 182,448 | 2,455,336 | 2,157 | 510,359 |

As noted in the table, the tonnage shipped from this district has steadily increased since 1904, reaching a gross value in 1911 of over $500,000. Producing mines in 1911 numbered 11, chief of which were the Atwood, Bonney, Dundee, Eighty-five, Superior, and Southern. All the ore from this district is siliceous, carrying chiefly copper, but also appreciable quantities of gold and silver. Some of the ore carries over 2.5 per cent (dry assay) copper, and much does not carry 2.5 per cent, but the average assay for the entire district for 1911 was gold 0.1118 ounce, silver 3.954 ounces, copper 2.66 per cent.

*Pinos Altos district.*—The placer mines in this district in 1911 made a production of $4,043 in gold, and deep mines yielded 355 tons of ore, with a gross value of $5,888 for all five metals, the total value for the district being $9,968, as compared with $4,119 in 1910, with $7,207 in 1909, and with $19,488 in 1908. The chief tonnage from the district was siliceous silver ore, carrying some copper and gold, from the Alaskan, Arizona, Cleveland, and Western Belle mines. Zinc sulphide screenings also were shipped from the Cleveland mine. During the year a 50-ton concentrating plant of rolls, screens, Richards classifiers, jigs, and Wilfley tables was built on the Cleveland property. Several cars of zinc (sulphide) concentrates were produced in the trial runs, but were not marketed until 1912. The sulphide ore consists of chalcopyrite and marmatite (sphalerite and iron sulphide). The surface oxidized lead and zinc ores were also prospected and tested in the mill.

*Red Hill district.*—No ore was shipped from the Red Hill district, in the southwestern corner of New Mexico.

*San Simon (or Granite Gap) district (Steins).*—Lead-silver ore was shipped from the Baby and Polly mines of the Granite Gap Co., San Simon district.

*Steeple Rock district.*—Ore-carrying gold and silver was shipped from the Hinckley mine by the American Exploration & Mining Co. On this property a 10-stamp cyanide plant was completed early in 1912. The old Carlisle mine was reopened early in 1912.

*Steins Pass (or Kimball) district.*—In the Steins Pass district development work was done on the National mine; the Volcano mine was idle.

*White Signal (or Cow Springs) district (Whitewater).*—Small shipments were made from the Bee, B. & M., and Mary and Mattie mines of the White Signal district. The ore from the Mary and Mattie is silver chloride with siliceous gangue.

### LINCOLN COUNTY.

The value of the output (chiefly gold) in Lincoln County in 1911 was $32,399, as compared with $55,849 in 1910 and with $24,499 in 1909. The placer yield increased slightly, but the deep-mine yield decreased appreciably. Placer gold production amounted to 78.80 fine ounces, valued at $1,629.

*Jicarilla district.*—The placer output of the county comes from Jicarilla. Deep mines in this district made no production.

The Littell Gold Mining Co. was engaged in testing ore from the Gold Stain mine in the Wisconsin mill. Development work was done on the Revenue and Murphy group mines.

*Nogal district.*—All the mines in the Nogal district were idle in 1911.

*White Oaks district.*—The output from White Oaks district in 1911 was less than in 1910. The Wild Cat Leasing Co., on the North and South Homestake mines, was again the chief producer, but the tonnage treated was less than in 1910 because of repairs being made to the mill and the erection of an electric power plant. No cyanidation was done in the 10-stamp mill in 1910 and the plan is to change the method from leaching to agitation. Lessees on the dump of the Old Abe mine sent some ore to the Old Abe cyanide mill. Development was made on the Silver Chief mine.

### LUNA COUNTY.

Luna County in 1911 produced 229 tons of ore, chiefly lead-silver, with a total value of $5,458, as compared with $14,490 in 1910, with $36,314 in 1909, and with $6,713 in 1908. The output of lead was 98,888 pounds, valued at $4,450. The output of lead in 1909 and 1910 was 682,906 pounds and 298,112 pounds, respectively.

*Cooks Peak district.*—Several small lots of lead-silver ore were shipped in 1911 from the Cooks Peak district.

*Tres Hermanas district.*—The Homestead Mining Co. has opened up lead and zinc ore. Some development was done on the Heatley group.

*Victorio district.*—Oxidized lead-silver ore with siliceous gangue was shipped from the Rambler and the Helen and Jessie mines. It was reported that zinc carbonate ore was opened in the Helen and Jessie mines.

### MORA COUNTY.

It was reported that arrangements are to be made for the introduction of a smelting and leaching process for the treatment of the copper ores of the Republic Mines Co., near Lucero, in Mora County.

### OTERO COUNTY.

The total value of the output of Otero County in 1911 from 5 deep mines was $9,971, chiefly in gold and copper. The value of the output in 1910 was $16,286, as compared with $1,098 in 1909 and with $132,454 in 1908.

*Sacramento district.*—Copper ore was opened in the Texas mine by the Sacramento Mining Co.

*Silver Hill (or Jarilla) district (near Brice).*—Oxidized ore carrying gold with iron in excess of silica was shipped from the Lucky mine of the Silver Hill district. Oxidized ore of the same character but carry-

ing small quantities of silver, copper, and lead in addition to the gold, was shipped from the Maggie and Nannie Baird mines. The Oro Grande smelter was idle in 1911.

*Tularosa district.*—Two small shipments of copper ore were made from Mescalero. The Tularosa Copper Co., operating the Virginia mine, did not operate its 125-ton concentration plant.

### QUAY COUNTY.

It is reported that copper ore was placed on the dump of the Twin Canyon mine, in the Morales district, near Logan, in Quay County.

### RIO ARRIBA COUNTY.

*Bromide district (Tusas).*—Assessment work only was done in this district. There is a 50-ton cyanide plant on the Tampa and Whale property.

### SANDOVAL COUNTY.[1]

*Cochiti district (Bland).*—There is a prospect of the reopening of mines in the Cochiti district.

*Nacimiento district (Senorito).*—A small lot of copper ore was shipped from the Nacimiento district in 1911.

### SANTA FE COUNTY.

The value of the mine production in 1911 in Santa Fe County from both placer and deep mines was $7,663, as compared with $26,173 in 1910, with $13,445 in 1909, and with $2,034 in 1908. Both deep and placer mine output decreased.

*Los Cerrillos district.*—There was a small quantity of placer gold handled by local merchants in Los Cerrillos district. The Sunset Mining & Milling Co., in reopening the Tom Payne mines, shipped some copper-lead ore to smelters. This company also has completed a 100-ton concentrating mill, and in purchasing the old Consolidated smelter has obtained a 100-ton lead and a 30-ton copper furnace. Several lots of copper ore were shipped from Los Cerrillos.

*New Placers district (San Pedro).*—The placer bullion of the New Placers district, as handled by local merchants from the various small placers, was slightly less than in 1910. A small quantity of bullion was shipped by lessees on the Gold Coin mine. The smelter of the Santa Fe Gold & Copper Mining Co. was idle in 1911.

### SIERRA COUNTY.

The Sierra County deep mines in 1911 yielded 5,036 tons carrying $26,962 in gold, 16,483 fine ounces of silver, 5,374 pounds of copper, and 28,088 pounds of lead, valued at $37,634. The placer output was $823 in gold and 4 ounces of silver, with a total value of $825. The value for both deep and placer mines was $38,459, as compared with $21,024 in 1910 and with $29,280 in 1909.

*Black Range and Apache districts (Chloride, Fluorine, and Kingston).*—There was no output from this region[2] in 1911. The U. S.

[1] Graton, L. C., Prof. Paper U. S. Geol Survey No. 68, 1910, pp. 140–162.
[2] Gordon, C. H., idem, pp. 260–266.

Treasury mine was developed during the building of a 50-ton blanket concentration and cyanide plant. The Black Range Reduction Co. has a 50-ton amalgamation, concentration, and cyanidation mill.

*Hermosa district.*—A small shipment was made from the Ocean Wave group in the Hermosa district; the mill was not operated.

*Las Animas district (Hillsboro).*—This district, as in 1909 and 1910, produced nearly all the gold of the county. There was an increase in gold output both from placers and deep mines. The Statehood Mines Co., operating the Snake and Eureka mines and the 30-stamp amalgamation and concentration mill, was the chief producer. Copper ore was shipped from the Wicks Gulch mine, and a small tonnage from the Mountain Ring was sent to the Statehood mill. The 20-stamp amalgamation and concentration mill of the Bonanza mine was not operated. An appreciable quantity of placer gold was recovered from the Luxemburg placer by the use of Quenner "dry washer" machines.

*Pittsburg district (Las Palomas).*—A small output of placer gold was made from the Pittsburg district.

*Tierra Blanca (or Bromide No. 1) district.*[1]—Low grade siliceous silver ore was shipped from the Lake Valley mines. A few tons of dry and copper ore carrying also gold and silver were shipped from the Log Cabin-Carbonate property.

## SOCORRO COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Socorro County, N. Mex., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 15,050.14 | $311,114 | 25,844.49 | $534,253 | +10,794.35 | +$223,139 |
| Silver.....do.... | 662,000 | 357,480 | 1,109,945 | 588,271 | + 447,945 | + 230,791 |
| Copper.....pounds.. | 152,284 | 19,340 | 79,321 | 9,915 | − 72,963 | − 9,425 |
| Lead.....do.... | 3,452,364 | 151,904 | 2,124,901 | 95,621 | −1,327,463 | − 56,283 |
| Zinc.....do.... | [1]18,013,370 | [1]972,722 | 9,930,281 | 566,026 | −8,083,089 | − 406,696 |
| Total..... | ..... | 1,812,560 | ..... | 1,794,086 | ..... | − 18,474 |

Socorro County, with a considerable increase in production of ore, again ranked first in tonnage and in total value of output. There was a marked increase in the production of gold and silver, but a considerable decrease in the output of lead and zinc.

*Cooney (or Mogollon) district.*—The production of Mogollon district in 1911 was 102,219 tons of ore, yielding $531,358 in gold, 1,067,038 fine ounces of silver, and a nominal quantity of copper and lead, with a total value of $1,097,206. This is $1\frac{3}{4}$ times the value of the yield for 1910. The gold output of this district represented 70 per cent of the State yield of this metal, and the silver yield, 79 per cent of the total silver output. In addition to the gold and silver production there was for 1911 a nominal quantity of copper and lead in concentrates.

There were 6 producing mines in this district, as against 3 in 1910, the tonnage increasing from 50,514 tons in 1910 to 102,219 tons in 1911, but the average assay per ton in terms of recovered gold and silver was lower than in 1910. The Ernestine Mining Co., operating the Last Chance mine, increased its tonnage output considerably.

[1] Op. cit., pp. 271–272.

The Socorro Mines Co. also greatly increased its tonnage milled. The Deadwood mill was started early in 1911 on ore from the Deadwood mine and treated also custom ore from the Mogollon Gold & Copper Co. and from the Pacific mine. The Treasure Mining & Reduction Co.'s mill was operated for the greater part of the year.

The Alberta Mining Co. continued development work. Development work was done on the Enterprise mine but the mill was idle. Ore from the Trilby group was stored.

*Magdalena district (Kelly).*—The output of zinc, the chief metal produced in this district, was 9,930,281 pounds, a decrease as compared with the yield in 1910. There were decreases also in the output of gold, silver, copper, and lead.

The Tri-Bullion Smelting & Development Co., operating in conjunction with lessees, the Tri-Bullion group, the Kelly, and the Starlight mines, was the chief producer. The Ozark Smelting & Refining Co. shipped lead and zinc carbonate ores to smelters from the Graphic mine. Zinc and lead carbonate ores were shipped from the Juanita mine.

According to the annual report of the Tri-Bullion Co. for the fiscal year ending October 31, 1911—

> the New Mexico properties produced 13,871 tons of zinc and lead concentrates, iron middlings, and zinc carbonates. The year's operations were on a par with 1910, comparing 14,645 tons shipped in the preceding fiscal period. The total income from ores, both company and lessees, was $271,739, which compares with $276,542 in 1910. The report shows the production for the year (for the company operations) to have been apportioned: zinc concentrates, 7,710 tons; lead concentrates, 1,404 tons; iron middlings, 4,525 tons; zinc carbonates, 232 tons. * * * .[1]

Lessees on the upper levels of the Kelly stopped operations in September, thereby causing a considerable decrease in the tonnage of zinc carbonates from this source. The lessees' tonnage output is not included in the report quoted.

The mill of the Tri-Bullion Co. has the following equipment: 8 Traylor tables, 2 Deister slime tables for the separation of lead from zinc, 4 Dean magnetic separators for separating of zinc from iron pyrites.

A considerable tonnage of milling ore was developed in the Germany mine.

*Rosedale district.*—A small output was made by the Rosedale Mining & Milling Co.

TAOS COUNTY.

*Rio Hondo district (Valdez).*—A 10-stamp concentrating plant was built at the Eureka mine of the Rio Hondo district. The ore is said to contain copper, silver, and gold.

## OREGON.

By Charles G. Yale.

### PRODUCTION.

The aggregate value of the mine production of gold, silver, and copper in Oregon in the calendar year 1911 was $669,016 as compared with $700,676 in 1910, a decrease of $31,660. The production was derived from 176 mines, of which 136 were placers of various

[1] Min. Sci., Dec. 21, 1911, p. 560.

kinds and 40 were deep mines. The number of deep mines producing in 1911 decreased by 24 and the number of placers increased by 20, resulting in a net decrease of 4 producing mines. Of the total output of 1911 the gold yield was 30,641.06 fine ounces, valued at $633,407; the silver yield was 45,221 fine ounces, valued at $23,967; and the copper, 93,136 pounds, valued at $11,642. The gold output in 1911 thus shows a decrease of $46,081; the silver an increase of 9,243 ounces; and the copper an increase of 79,275 pounds. The total quantity of ore mined and treated in 1911 was 98,558 tons, an increase of 16,426 tons over that of 1910. The quantity of siliceous ore sold or treated was 94,353 short tons in 1911 (including 44,246 tons of old tailings) against 82,064 tons (including 12,142 tons of old tailings) in 1910, an increase for 1911 of 12,289 tons. The copper ores in 1911 amounted to 4,205 tons as compared with 68 tons in 1910, an increase of 4,137 tons. The average value of siliceous ore per ton in 1911 was $5.03 in gold and silver as compared with $6.42 in 1910, $9.87 in 1909, and $12.49 in 1908. This gradual falling off in average yield may be accounted for in part at least by the fact that an increased quantity of old tailings was worked in each succeeding year until, in 1911, the tailings amounted to 47 per cent of the entire quantity of siliceous ore treated in the State. The copper ore sold or treated in 1911 yielded an average value of $3.32 per ton in gold and silver as compared with $4.85 in 1910 and with $2.92 in 1909.

There were treated in 1911 at gold and silver mills 49,478 tons of ore, yielding $309,647 in gold and 22,966 fine ounces of silver. In milling the ore $162,518 in gold and 2,528 fine ounces of silver were recovered by ordinary plate amalgamation, the average value being $3.29 in gold and 3 cents in silver per ton. The concentrates saved from all concentrating ore were 1,493 tons in quantity, yielding $147,129 in gold and 20,438 ounces of silver, an average value of $98.55 in gold and $7.26 in silver per ton. The average total extraction per ton of crude ore in gold and silver mills, both by amalgamation and in the concentrates, was valued at $6.26 in gold and 25 cents in silver. Crude siliceous ore shipped to smelters amounted to 629 tons, containing $74,868 in gold and 7,056 ounces of silver, an average value per ton of $119.03 in gold and $5.95 in silver. In addition there were 4,205 tons of copper ore smelted, which yielded $8,692 in gold, 9,953 ounces of silver, and 93,136 pounds of copper, valued at $11,642. The copper ores yielded $2.07 in gold, 2.4 ounces in silver, and 22.2 pounds of copper per ton. There were 44,246 tons of old tailings treated, yielding $71,926 in gold and 3,989 ounces of silver, an average value of $1.63 in gold and 5 cents in silver per ton.

The production in 1910 and 1911 of gold, silver, and copper in Oregon was as follows:

*Mine production of gold, silver, and copper in Oregon in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 32,870.23 | $679,488 | 30,641.06 | $633,407 | − 2,229.17 | −$46,081 |
| Silver.....do.... | 35,978 | 19,428 | 45,221 | 23,967 | + 9,243 | + 4,539 |
| Copper.....pounds.. | 13,861 | 1,760 | 93,136 | 11,642 | + 79,275 | + 9,882 |
| Total..... | ..... | 700,676 | ..... | 669,016 | ..... | − 31,660 |

GOLD.

The total output of gold in Oregon in 1911 was 30 ep mines. valued at $633,407, a decrease of 2,229.17 fin and of $46,081 in value, as compared with largest yield in gold from one county, usual from Baker County, although t the yield of the county in 1910 Josephine, followed by Jackson order named. The largest m Baker County, and of plac most productive quartz m the most productive pl deep mines (includin was 25 less than as compared w

| Siliceous ore. | Copper ores. | Total. | Grand total. |
|---|---|---|---|
| 30,766 | ..... | 30,766 | 30,944 |
| ..... | ..... | ..... | 13 |
| ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | 53 |
| 21 | ..... | 21 | 78 |
| 2,226 | ..... | 2,226 | 2,320 |
| 464 | ..... | 464 | 757 |
| 42 | 9,953 | 9,995 | 10,436 |
| 466 | ..... | 466 | 466 |
| 26 | ..... | 26 | 126 |
| ..... | ..... | ..... | 28 |
| 34,011 | 9,953 | 43,964 | 45,221 |
| −193 | +9,418 | +9,225 | +9,243 |

COPPER.

The mine production of copper in Oregon in 1911 was 93,136 pounds, valued at $11,642, an increase in quantity over 1910 of 79,275 pounds, and in value of $9,882. The copper ore also carried gold to the value of $8,692, and in addition 9,953 ounces of silver. There are only two productive copper mines in the State—one in Josephine and the other in Malheur County.

## MINING INDUSTRY IN OREGON IN 1911.

The southwestern counties of Oregon, which form an extension of the California gold belt, are Benton, Coos, Curry, Douglas, Jackson, Josephine, and Lane. These counties (with the exception of Benton, which made no output) made in 1911 a combined gold production of $188,971, which was $20,353 less than in 1910. The production of placer gold from this region in 1911 was $123,008, a decrease of $7,095, and the gold production from deep mines was $65,963, a decrease of $13,258. The silver production of southwestern Oregon in 1911 was 11,803 fine ounces, an increase of 9,573 ounces. Of the total decrease in gold in this section 35 per cent was due to the falling off in placer production, and 65 per cent to reduction in quartz gold output. In 1911 there was a decrease of $7,095 in placer gold; in 1910 a decrease of $55,149; in 1909 a decrease of $8,232; and in 1908 a decrease of $46,458. The decrease of gold yield from deep mines was $13,258 in 1911; $9,772 in 1910; $63,670 in 1909; and $99,376 in 1908.

The history of gold mining in southwestern Oregon dates back for more than 50 years, the first discovery having been made about the middle of the last century. From that time to the present (1907) this portion of the State has yielded a considerable percentage of the total gold yield of Oregon. The two counties from which most of the gold has come are Josephine and Jackson, both of which lie partly within the Riddles quadrangle.

In the early days practically all of the output came from the placers. Between 1880 and 1890 there was a small but gradually increasing yield from the gold in quartz mines. During the succeeding 10 years the production of the placers continued to decrease and that of the gold-quartz mines to increase.[1]

[1] Diller, J. S., and Kay, G. F., Bull. U. S. Geol. Survey No. 340, 1908, p. 135.

The following table shows the output of placer gold by classes of mines in Oregon, by counties, in 1911:

*Output in Oregon in 1911, by counties, by classes of mines.*

| | Hydraulic. | Drift. | Dredging. | Surface placers. | Total. |
|---|---|---|---|---|---|
| | $2,248 | $10,548 | ..... | $4,585 | $17,381 |
| | ..... | ..... | ..... | 1,520 | 1,520 |
| | ..... | ..... | ..... | 214 | 214 |
| | 156 | ..... | ..... | 6,866 | 7,022 |
| | ..... | ..... | ..... | 128 | 2,169 |
| | ..... | ..... | $1,798 | 851 | 11,849 |
| | ..... | ..... | 12,455 | 82 | 25,740 |
| | 6,986 | ..... | 322 | 6,238 | 86,557 |
| | ..... | ..... | ..... | 2,682 | 12,860 |
| | ..... | ..... | ..... | ..... | 2,962 |
| | 575 | ..... | ..... | 23,166 | 168,274 |

resulting in a net de
of 1911 the gold yield
the silver yield was 45,22
copper, 93,136 pounds, value
thus shows a decrease of $46,0
ounces; and the copper an increa
quantity of ore mined and treated in
of 16,426 tons over that of 1910. The
or treated was 94,353 short tons in 191
old tailings) against 82,064 tons (including
ings) in 1910, an increase for 1911 of 12,289
in 1911 amounted to 4,205 tons as compared w
an increase of 4,137 tons. The average value of silic
in 1911 was $5.03 in gold and silver as compared with $9.87 in 1909, and $12.49 in 1908. This gradual falling on in average yield may be accounted for in part at least by the fact that an increased quantity of old tailings was worked in each succeeding year until, in 1911, the tailings amounted to 47 per cent of the entire quantity of siliceous ore treated in the State. The copper ore sold or treated in 1911 yielded an average value of $3.32 per ton in gold and silver as compared with $4.85 in 1910 and with $2.92 in 1909.

There were treated in 1911 at gold and silver mills 49,478 tons of ore, yielding $309,647 in gold and 22,966 fine ounces of silver. In milling the ore $162,518 in gold and 2,528 fine ounces of silver were recovered by ordinary plate amalgamation, the average value being $3.29 in gold and 3 cents in silver per ton. The concentrates saved from all concentrating ore were 1,493 tons in quantity, yielding $147,129 in gold and 20,438 ounces of silver, an average value of $98.55 in gold and $7.26 in silver per ton. The average total extraction per ton of crude ore in gold and silver mills, both by amalgamation and in the concentrates, was valued at $6.26 in gold and 25 cents in silver. Crude siliceous ore shipped to smelters amounted to 629 tons, containing $74,868 in gold and 7,056 ounces of silver, an average value per ton of $119.03 in gold and $5.95 in silver. In addition there were 4,205 tons of copper ore smelted, which yielded $8,692 in gold, 9,953 ounces of silver, and 93,136 pounds of copper, valued at $11,642. The copper ores yielded $2.07 in gold, 2.4 ounces in silver, and 22.2 pounds of copper per ton. There were 44,246 tons of old tailings treated, yielding $71,926 in gold and 3,989 ounces of silver, an average value of $1.63 in gold and 5 cents in silver per ton.

The production in 1910 and 1911 of gold, silver, and copper in Oregon was as follows:

*Mine production of gold, silver, and copper in Oregon in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 32,870.23 | $679,488 | 30,641.06 | $633,407 | − 2,229.17 | −$46,081 |
| Silver.....do.... | 35,978 | 19,428 | 45,221 | 23,967 | + 9,243 | + 4,539 |
| Copper.....pounds.. | 13,861 | 1,760 | 93,136 | 11,642 | + 79,275 | + 9,882 |
| Total..... | ..... | 700,676 | ..... | 669,016 | ..... | − 31,660 |

*Source of silver production in Oregon, by kinds of ore, in 1911, in fine ounces.*

| County. | Placers. | Deep mines. | | | Grand total. |
|---|---|---|---|---|---|
| | | Siliceous ore. | Copper ores. | Total. | |
| Baker | 178 | 30,766 | ..... | 30,766 | 30,944 |
| Coos | 13 | ..... | ..... | ..... | 13 |
| Crook | ..... | ..... | ..... | ..... | ..... |
| Curry | 53 | ..... | ..... | ..... | 53 |
| Douglas | 57 | 21 | ..... | 21 | 78 |
| Grant | 94 | 2,226 | ..... | 2,226 | 2,320 |
| Jackson | 293 | 464 | ..... | 464 | 757 |
| Josephine | 441 | 42 | 9,953 | 9,995 | 10,436 |
| Lane | ..... | 466 | ..... | 466 | 466 |
| Malheur | 100 | 26 | ..... | 26 | 126 |
| Wheeler | 28 | ..... | ..... | ..... | 28 |
| Total | 1,257 | 34,011 | 9,953 | 43,964 | 45,221 |
| Increase (+) or decrease (−) | +18 | −193 | +9,418 | +9,225 | +9,243 |

## COPPER.

The mine production of copper in Oregon in 1911 was 93,136 pounds, valued at $11,642, an increase in quantity over 1910 of 79,275 pounds, and in value of $9,882. The copper ore also carried gold to the value of $8,692, and in addition 9,953 ounces of silver. There are only two productive copper mines in the State—one in Josephine and the other in Malheur County.

## MINING INDUSTRY IN OREGON IN 1911.

The southwestern counties of Oregon, which form an extension of the California gold belt, are Benton, Coos, Curry, Douglas, Jackson, Josephine, and Lane. These counties (with the exception of Benton, which made no output) made in 1911 a combined gold production of $188,971, which was $20,353 less than in 1910. The production of placer gold from this region in 1911 was $123,008, a decrease of $7,095, and the gold production from deep mines was $65,963, a decrease of $13,258. The silver production of southwestern Oregon in 1911 was 11,803 fine ounces, an increase of 9,573 ounces. Of the total decrease in gold in this section 35 per cent was due to the falling off in placer production, and 65 per cent to reduction in quartz gold output. In 1911 there was a decrease of $7,095 in placer gold; in 1910 a decrease of $55,149; in 1909 a decrease of $8,232; and in 1908 a decrease of $46,458. The decrease of gold yield from deep mines was $13,258 in 1911; $9,772 in 1910; $63,670 in 1909; and $99,376 in 1908.

The history of gold mining in southwestern Oregon dates back for more than 50 years, the first discovery having been made about the middle of the last century. From that time to the present (1907) this portion of the State has yielded a considerable percentage of the total gold yield of Oregon. The two counties from which most of the gold has come are Josephine and Jackson, both of which lie partly within the Riddles quadrangle.

In the early days practically all of the output came from the placers. Between 1880 and 1890 there was a small but gradually increasing yield from the gold in quartz mines. During the succeeding 10 years the production of the placers continued to decrease and that of the gold-quartz mines to increase.[1]

[1] Diller, J. S., and Kay, G. F., Bull. U. S. Geol. Survey No. 340, 1908, p. 135.

It will be seen that the gradual decrease in placer gold in southwestern Oregon noted by Messrs. Diller and Kay in 1907, still continues and that there has been for the last few years a decrease on the part of the deep gold mines also.

Northeastern Oregon comprises the counties of Baker, Crook, Grant, Harney, Malheur, Umatilla, Union, Wallowa, and Wheeler. In 1911 the counties of Harney, Umatilla, Union, and Wallowa produced no gold or silver. The combined gold output of this region in 1911 was $444,436, a decrease of $25,728. The placer-gold yield was $45,266 in 1911, an increase of $4,444. The lode mines produced $399,170 in gold, a decrease of $30,172. The silver production of northeastern Oregon in 1911 was 33,418 ounces, valued at $17,712, almost the same as in 1910. The placer-gold yield of these counties in 1910 was $40,822, an increase of $4,756; in 1909 it was $43,043 less than in 1908; and in 1908 it was $12,355 less than in 1907. The gold production from lode mines in 1911 was $399,170, a decrease of $30,172; in 1910 it was $429,342, a decrease of $42,311; in 1909 it was $63,670 less than in 1908; and in 1908 it was $105,784 less than in 1907. Although in both 1911 and 1910 the placer gold showed some increase over the previous years, there is a general decline in the output of the gold mines of this section.

The subdivision of tonnage and production of gold and silver in Oregon in 1911, according to methods of treatment, is shown in the following table:

*Subdivision of tonnage and production of gold and silver in Oregon, in 1911, according to methods of treatment, by counties.*

| County. | Ore to gold and silver mills. | | | Concentrates treated. | | |
|---|---|---|---|---|---|---|
| | Tonnage. | Gold (value). | Silver (fine ounces). | Tonnage. | Gold (value). | Silver fine ounces). |
| Baker | 34,067 | $97,503 | 1,100 | 1,176 | $135,816 | 19,217 |
| Douglas | 437 | 2,156 | 21 | 8 | 60 | ..... |
| Grant | 4,335 | 18,847 | 728 | 127 | 4,856 | 1,185 |
| Jackson | 4,643 | 8,645 | 159 | 178 | 6,223 | 23 |
| Josephine | 1,165 | 4,114 | 41 | ..... | ..... | ..... |
| Lane | 4,514 | 30,154 | 466 | ..... | ..... | ..... |
| Malheur | 317 | 1,099 | 13 | 4 | 174 | 13 |
| Total | 49,478 | 162,518 | 2,528 | 1,493 | 147,129 | 20,438 |
| Average value per ton | ..... | 3.29 | $0.03 | ..... | 98.55 | $7.26 |

| County. | Crude ore to smelter. | | | Old tailings treated. | | |
|---|---|---|---|---|---|---|
| | Tonnage. | Gold (value). | Silver (fine ounces). | Tonnage. | Gold (value). | Silver (fine ounces) |
| Baker | 545 | $70,660 | 6,528 | 39,946 | $68,426 | 3,921 |
| Douglas | ..... | ..... | ..... | ..... | ..... | ..... |
| Grant | 47 | 1,789 | 313 | ..... | ..... | ..... |
| Jackson | 37 | 2,419 | 215 | 4,300 | 3,500 | 68 |
| Josephine | 4,159 | 8,692 | 9,953 | ..... | ..... | ..... |
| Lane | ..... | ..... | ..... | ..... | ..... | ..... |
| Malheur | 46 | ..... | ..... | ..... | ..... | ..... |
| Total | 4,834 | 83,560 | 17,009 | 44,246 | 71,926 | 3,989 |
| Average value per ton | ..... | 17.29 | $1.87 | ..... | 1.63 | $0.05 |

Average recovery value (per ton) from both bullion and concentrates: Gold = $6.26; silver = $0.25.

The total tonnage, by kinds of ore sold or treated, in each county in Oregon in 1911 is shown in the following table:

*Subdivision of tonnage of ore sold or treated in Oregon in 1911, by counties, in short tons.*

| County. | Siliceous ore. | Copper ores. | Total ore. |
|---|---|---|---|
| Baker | 74,558 | ..... | 74,558 |
| Douglas | 437 | ..... | 437 |
| Grant | 4,382 | ..... | 4,382 |
| Jackson | 8,980 | ..... | 8,980 |
| Josephine | 1,165 | 4,159 | 5,324 |
| Lane | 4,514 | ..... | 4,514 |
| Malheur | 317 | 46 | 363 |
| Total | 94,353 | 4,205 | 98,558 |
| Increase | 12,289 | 4,137 | 16,426 |
| Average value per ton in gold and silver | $5.03 | $3.32 | $4.96 |

The following table gives the number of producing mines, classified according to their chief product, in the counties of Oregon in 1911:

*Number of mines, classified by chief product, in Oregon in 1911, by counties.*

| County. | Gold placer mines. | | | | | Deep mines. | | | Total producing mines. |
|---|---|---|---|---|---|---|---|---|---|
| | Hydraulic. | Dredging. | Drift. | Surface. | Total. | Gold. | Copper. | Total. | |
| Baker | 8 | ..... | 6 | 9 | 23 | 11 | ..... | 11 | 34 |
| Coos | ..... | ..... | ..... | 4 | 4 | ..... | ..... | ..... | 4 |
| Crook | ..... | ..... | ..... | 1 | 1 | ..... | ..... | ..... | 1 |
| Curry | 2 | ..... | ..... | 6 | 8 | ..... | ..... | ..... | 8 |
| Douglas | 6 | ..... | ..... | 2 | 8 | 3 | ..... | 3 | 11 |
| Grant | 10 | 1 | ..... | 2 | 13 | 8 | ..... | 8 | 21 |
| Jackson | 16 | 1 | ..... | 1 | 18 | 6 | ..... | 6 | 24 |
| Josephine | 38 | 1 | 3 | 9 | 51 | 7 | 1 | 8 | 59 |
| Lane | ..... | ..... | ..... | ..... | ..... | 3 | ..... | 3 | 3 |
| Malheur | 6 | ..... | ..... | 2 | 8 | ..... | 1 | 1 | 9 |
| Wheeler | 2 | ..... | ..... | ..... | 2 | ..... | ..... | ..... | 2 |
| Total | 88 | 3 | 9 | 36 | 136 | 38 | 2 | 40 | 176 |

The following table shows the mine production of gold, silver, and copper in Oregon in 1911, by counties, with the tonnage:

*Production of precious metals in Oregon in 1911, by source, and production of copper, by counties.*

| County. | Ore treated. | Quartz gold. | | Placer gold. | | Total gold. | |
|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | *Short tons.* | *Fine ounces.* | | *Fine ounces.* | | *Fine ounces.* | |
| Baker | 74,558 | 18,015.09 | $372,405 | 840.81 | $17,381 | 18,855.90 | $389,786 |
| Coos | ..... | ..... | ..... | 73.53 | 1,520 | 73.53 | 1,520 |
| Crook | ..... | ..... | ..... | 10.35 | 214 | 10.35 | 214 |
| Curry | ..... | ..... | ..... | 339.69 | 7,022 | 339.69 | 7,022 |
| Douglas | 437 | 107.20 | 2,216 | 104.92 | 2,169 | 212.12 | 4,385 |
| Grant | 4,382 | 1,233.18 | 25,492 | 573.19 | 11,849 | 1,806.37 | 37,341 |
| Jackson | 8,980 | 1,005.57 | 20,787 | 1,245.17 | 25,740 | 2,250.74 | 46,527 |
| Josephine | 5,324 | 619.49 | 12,806 | 4,187.20 | 86,557 | 4,806.69 | 99,363 |
| Lane | 4,514 | 1,458.70 | 30,154 | ..... | ..... | 1,458.70 | 30,154 |
| Malheur | 363 | 61.58 | 1,273 | 622.10 | 12,860 | 683.68 | 14,133 |
| Wheeler | ..... | ..... | ..... | 143.29 | 2,962 | 143.29 | 2,962 |
| Total | 98,558 | 22,500.81 | 465,133 | 8,140.25 | 168,274 | 30,641.06 | 633,407 |

*Production of precious metals in Oregon in 1911, by source, and production of copper, by counties*—Continued.

| County. | Quartz silver. | | Placer silver. | | Total silver. | | Copper. | | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ounces.* | | *Fine ounces.* | | *Fine ounces.* | | *Pounds.* | | |
| Baker | 30,766 | $16,306 | 178 | $94 | 30,944 | $16,400 | | | $406,186 |
| Coos | | | 13 | 7 | 13 | 7 | | | 1,527 |
| Crook | | | | | | | | | 214 |
| Curry | | | 53 | 28 | 53 | 28 | | | 7,050 |
| Douglas | 21 | 11 | 57 | 30 | 78 | 41 | | | 4,426 |
| Grant | 2,226 | 1,180 | 94 | 50 | 2,320 | 1,230 | | | 38,571 |
| Jackson | 464 | 246 | 293 | 155 | 757 | 401 | | | 46,928 |
| Josephine | 9,995 | 5,297 | 441 | 234 | 10,436 | 5,531 | 82,808 | $10,351 | 115,245 |
| Lane | 466 | 247 | | | 466 | 247 | | | 30,401 |
| Malheur | 26 | 14 | 100 | 53 | 126 | 67 | 10,328 | 1,291 | 15,491 |
| Wheeler | | | 28 | 15 | 28 | 15 | | | 2,977 |
| Total | 43,964 | 23,301 | 1,257 | 666 | 45,221 | 23,967 | 93,136 | 11,642 | 669,016 |

## PRODUCTION BY COUNTIES.[1]

### BAKER COUNTY.

The total value of the metals mined in Baker County in 1911 was $406,186, as compared with $418,873 in 1910, a decrease of $12,687 for 1911. The yield in gold, valued at $389,786 in 1911, was $11,216 less than in 1910, and the yield of silver of 30,944 ounces, valued at $16,400, was an increase of 1,109 ounces. There was no yield of copper from the county in 1911, although in 1910 there was a production of 13,861 pounds, valued at $1,760. There were 34 producing mines in the county in 1911 as compared with 54 in 1910. The placers numbered 23, of which 8 were hydraulic, 6 drift, and 9 surface placers. The placers combined yielded $17,381 in gold and 178 ounces of silver in 1911, as compared with $11,276 in gold and 117 ounces of silver in 1910. The total number of producing deep mines in 1911 was 11, and their output of siliceous ore was 74,558 tons, or 18,363 tons more than in 1910. The gold yield of this ore was valued at $372,405, and the silver yield was 30,766 fine ounces, valued at $16,306. The average value of the ores per ton was $4.99 in gold and 22 cents in silver, a total of $5.21 per ton in 1911, as compared with $6.93 in gold and 3 cents in silver, a total of $6.96 per ton in 1910. Of the total of 74,558 tons of siliceous ore, 34,067 tons were treated at gold and silver mills and yielded $97,503 in gold and 1,100 fine ounces of silver (valued at $583) by amalgamation, an average value per ton of $2.86 in gold and 2 cents in silver. From the 34,067 tons of milling ore were derived 1,176 tons of concentrates, yielding $135,816 in gold and 19,217 fine ounces of silver, a total value of $146,001, or an average value of $124.15 per ton. The quantity of concentrates was 684 tons less than in 1910, and the average value was $58.29 per ton greater. Crude ore was shipped to smelters to the amount of 545 tons, and yielded $70,660 in gold and 6,528 fine ounces of silver, a total value for the smelting ores of $74,120, or an average of $136 per ton. In addition to this there were 39,946 tons of old tailings treated, yielding

[1] For references to Survey literature on the mining districts, see Hill, J. M., The mining districts of the western United States: Bull. U. S. Geol. Survey No. 507, 1912.

$68,426 in gold, and 3,921 ounces of silver, an average value of $1.77 per ton.

*Baker district.*—The mines at Baker City and Virtue are included in this district. Six placer mines and 1 deep mine were productive in 1911 and yielded $12,552 in gold and 5,989 ounces of silver. The only productive deep mine was that of the Highland Gold Mines Co., whose ores were shipped to a smelter for treatment. A new reduction plant and 60-ton concentrating plant were in course of construction in December, 1911, to be completed in April, 1912. The property is developed by about 8,000 feet of tunnel, and approximately 2,000 feet of work was done in 1911. The placers in this district are all small sluicing properties.

*Bonanza district.*—There are 2 small producing deep mines in the Bonanza district—the Bonanza, at Geiser, and the Golden Eagle, at Greenhorn. Their combined output was $3,072 gold and 43 ounces of silver.

*Bridgeport district.*—The Surprise placer is a small producer in the Bridgeport district.

*Connor Creek district.*—The only deep producing mine at Connor Creek is that of the Connor Creek Mining Co., which, though equipped with a 20-stamp mill, did little work in 1911. The Huntington and Kaufmann are 2 small mines worked on the hydraulic system.

*Cornucopia district.*—The Cornucopia is the most prominent mine in this district. It has a 20-stamp amalgamation and concentration mill and in 1911 was developed by 4,000 feet of drifts, raises, and crosscuts. The plant was operated the whole year. The W. P. C. Co., at the same place, has a 35-ton cyanide plant for treating tailings. The Underwood, a new drift mine, is in an ancient gravel channel on Pine Creek, 2 miles south of Cornucopia, where considerable development work is being done. The total output of the mines in this district in 1911 was $145,497 gold and 21,976 ounces of silver, with a total value of $157,144.

*Cracker Creek district.*—The Cracker Creek district is the most productive in Oregon, although there are only 5 mines with reported yield. One of these, the largest producer in the State, is the Columbia, at Sumpter, which is developed by a 3-compartment shaft 918 feet deep with levels each 100 feet, and 3 tunnels, 2,048 feet. The 20-stamp mill is equipped with concentrators and cyanide plant, and there are auxiliary rolls and trommels. The mill was operated 8,448 hours in 1911. The Belle of Baker mine at the same place has a 370-foot shaft, 1,000 feet of drifts, and an 800-foot adit. A 5-foot Bryan mill is used for crushing and amalgamating the ore. None of the mines at Bourne, in this district, were reported productive in 1911, although in 1910 the Climax, Northwestern, South Pole, and Taylor were all producing. The North Pole mine is being reopened after having been closed down three years. The producing placers in the district yielded $972 gold.

*Durkee and Mormon Basin districts.*—In Durkee district are 2 small producing placer mines. In Mormon Basin district there are 2 deep mines and 1 placer, with a combined yield of $16,483 gold and 1,402 ounces of silver, with a total value of $17,226. The largest producer was the Rainbow mine. The output was all derived from the cyanidation of tailings by lessees, though considerable development work

is being done on the mine. The Raccoon has a 3-stamp mill. The producing placer in this district is the Rye Valley hydraulic mine.

*Pine Creek, Richland, and Weatherby districts.*—In Pine Creek district 4 drift mines and 1 hydraulic made a combined output of $1,243 in gold. In Richland district 1 small placer was productive. In Weatherby district 1 quartz mine and 1 placer made a combined yield of $1,066 gold.

### COOS AND CROOK COUNTIES.

Coos County made a production of $1,520 gold and 13 ounces of silver in 1911, as compared with $384 gold and 4 ounces of silver in 1910. The producers were the Whisky Run and Independence beach-sand mines at Bullards in Randolph district, and the Buckeye Bar and Flanagan Bar sluicing mines in Johnson Creek district. In Crook County from which there was no yield reported in 1910, one placer made a nominal output in 1911.

### CURRY COUNTY.

The entire output of Curry County, amounting to $7,022 in gold and 53 ounces of silver in 1911, was derived from surface mines. The same was the case in 1910 when the yield was $3,225 in gold and 18 ounces of silver, with a total value of $3,235. At Cape Blanco district at Port Orford, are the Elgin, Sullivan, and Myrtle placers, the latter a beach-sand mine. The Golden Dream placer at Harbor, in Chetco district, is the largest producer in the county. Decomposed material is being sluiced at the head of Slide Creek, a branch of Chetco River. At Billings, in Mule Creek district, a small placer is being operated. The Kalamazoo and Ophir Creek sluice mines made a small production in Ophir district; and there are some small placers at Wedderburn.

### DOUGLAS COUNTY.

Douglas County in 1911 made a production of $4,385 in gold and 78 ounces of silver, a total of $4,426 in value, as compared with $9,147 in gold and 98 ounces of silver in 1910, a total of $9,200 in value. Three deep mines and 8 placers were reported productive in 1911. The deep-mine gold amounted to $2,216, and the placer gold to $2,169. In Bohemia district only 1 quartz mine produced, and this in a small way. In Green Mountain district there are 6 placers and 1 deep mine producing. Of the placers the Miser, Douglas, and Victor are hydraulic properties, and the others are small sluicing mines. In Myrtle Creek district the Buck Fork hydraulic mine is the only producer. At Nugget the only productive mine is the Continental, a quartz property. In Ollala district is the Red Bell, a small hydraulic mine. From the deep mines of the county only 437 tons of ore were treated in 1911, yielding, as stated, $2,216.

### GRANT COUNTY.

The production of Grant County in 1911 was $37,341 in gold and 2,320 ounces of silver, a total in value of $38,571, as compared with $37,455 in 1910. There were 8 deep producing mines in the county and 13 placers. The deep mines produced 4,382 tons of ore, yielding

$25,492 in gold and 2,226 ounces of silver; and the placers produced $11,849 in gold and 94 ounces of silver. In Beech Creek district there is only 1 producing placer, the Black Butte, a hydraulic mine. In Canyon Mountain district are 3 hydraulic mines, the Caledonia, the Marysville, and the Quartz Gulch, with a combined output of $6,355 in gold and 185 ounces of silver, with a total value of $6,453. In Granite district are 2 deep and 5 placer mines. The deep mines are the George Washington and the Independence. The placers are the Gold Center (dredge) and the Independence, O'Dare, Onion Creek, and Trail Creek hydraulic mines. The combined output of these placers was $2,687 in gold.

Greenhorn district has 2 deep producing mines and 1 placer, the latter the Listen Lake surface mine. Of the deep mines the Morning has a 5-foot Bryan mill with Wilfley tables. The Intermountain group made a nominal output. The gold output of Greenhorn district was $8,787 in gold and 549 ounces of silver, with a total value of $9,078. The Goldfield quartz pocket is the only producing mine in Poker Gulch district, and the Colorado the only one in Quartzburg district. In Red Boy district the only producer is the Red Boy, which is equipped with a 10-stamp mill and concentrators. In Susanville district there are 1 producing deep mine and 2 placers. The Maisie Ridge is the only deep mine. The gold output of the district was $1,271, with 9 ounces of silver and a total value of $1,276. A nominal output was derived from a hydraulic mine in Ukiah district.

### JACKSON COUNTY.

In Jackson County there are 6 productive deep mines and 18 placers; of the latter 16 are hydraulic, 1 is a dredge, and 1 a surface placer. The placers yielded $25,740 in gold and 293 ounces of silver, a total value of $25,895; and the deep mines yielded $20,787 in gold and 464 ounces of silver, a total value of $21,033. The value of the output of the county in 1911 was $46,527 in gold and 757 ounces of silver, a total of $46,928. In 1910 the value of the gold yield was $42,466, and of the silver (1,078 ounces) was $582, a total of $43,048. The increase in gold output for 1911 was $4,061. In Applegate district the Shattuck mine made a small product in 1911 from "specimen ore." The machinery for a 10-stamp mill is on the ground to be put in operation in the summer of 1912. The Pittock Bros. hydraulic mine was operated in the same district. Foots Creek district has 11 productive placers, the combined output of which in 1911 was $20,050 in gold and 181 ounces of silver, with a total value of $20,146. These placers are the Iron Gulch, Carr Bros., Glen Ditch, Electric Gold Dredging Co., Hays, Magee, and Lance Bros., all hydraulic mines, the Blackert sluicing mine, and the Champlin dredge. This dredge was sunk early in the fall of 1911 and has since been dismantled, the land now being farmed. In Jacksonville district are 2 productive deep mines and 3 placers. The deep mines are the Norling and the Opp. The Norling has a 5-stamp mill and was operated for only two months during the year after it was sold to the Medford Co. The Opp mine has a 20-stamp mill and a 125-ton cyanide plant, which was operated 6½ months in 1911. The 3 hydraulic mines operating in the district are the Crouch, Forest

Creek, and Spaulding. In Jump Off Joe district there is only 1 productive hydraulic mine; and in Medford district 1 small quartz mine. In Pleasant Creek district the Sykes Creek Mining Co. is operating a hydraulic mine. Sardine Creek district has only 1 small surface placer which is productive. In Tolo district the Gold Hill and Whitney are quartz mines operated in a small way.

### JOSEPHINE COUNTY.

The total output of gold, silver, and copper in Josephine County in 1911 was valued at $115,245, as compared with $150,569 in 1910, a decrease of $35,324. The gold yield was $99,363; the silver, 10,436 ounces; and the copper, 82,808 pounds. There was no copper production in the county in 1910. The 8 deep mines in the county in 1911 produced 5,324 tons of ore, 619.49 fine ounces of gold, valued at $12,806; with 9,995 ounces of silver, valued at $5,297, and 82,808 pounds of copper, valued at $10,351. The value of the deep mine output of the county in all metals was thus $28,454. The 51 placer mines yielded 4,187.20 ounces of gold, valued at $86,557, and 441 ounces of silver, valued at $234, a total value of $86,791. Of the placer gold, $73,011 was derived from 38 hydraulic mines, $6,986 from 3 drift mines, and the rest from 1 dredge and 9 surface placers. The placer gold output exceeded that of the deep mines by $73,751; but values of all metals considered, the total placer yield exceeded that of the deep mines by $58,337. The falling off in gold yield of this county in 1911, as compared with the output of 1910, amounting to $50,685, is the largest county decrease in the State. Of the ore produced in the county, 1,165 tons were treated at gold and silver mills and 4,159 tons were shipped to smelters for treatment. The falling off in tonnage of ore mined and treated amounted to 11,091 tons in 1911, and this accounts for the reduction of gold yield. The Greenback mine, at Placer post office, was a large producer in tonnage and gold in 1910 and a small one in 1911, it having been closed most of the summer. The Mountain Lion at Davidson, and the Oriole and Sugar Pine at Galice, which were producers in 1910, made no output in 1911. At Althouse or Sucker Creek district there are 13 placers and 1 deep mine, the latter the "January First" at Holland. None of these are large producers, the entire gold yield of the district having been $10,116. At Applegate there is 1 small producing hydraulic mine. In Briggs Creek district are 2 productive hydraulic mines, the Barr and the Cougar Consolidated. Galice district has 3 quartz mines and 9 placers. One of the deep mines is the Almeda Consolidated, which has a 100-ton smelting plant at Galice, and where 7,396 feet of underground work has been done. The Black Jack is a small quartz mine with no reduction plant, and the Strenuous Teddy is a pocket mine. Among the productive placers in this district are the Gold Bar and Rocky Gulch, Galice Consolidated, Oregon Placer, Rogue River, and Scandinavian-American (dredge). Of these the Gold Bar and Rocky Gulch was worked for a short time by drag-line excavator and hydraulic elevator; the Rogue River also used an excavator and hydraulic elevator, the machinery being merely tested during the season. The Scandinavian-American Dredge Co. completed its dredge late in the summer, and thus had only a few days

to run. In Grave Creek district, near Leland and Placer post office, are 4 deep producing mines and 8 placers. The Gold Note Mining Co. installed a triple-discharge 3-stamp mill and 10-ton cyanide plant during the year. The Greenback Mining Co. materially reduced its output as compared with that of 1910. The Toughnut has a 3-stamp mill in operation, and the Martha made a nominal yield. Of the placers, all hydraulic, the following are producers: Archer, Crackerjack, Ideal, Goft-Abbot, McMickle, and Columbia. The total yield of Grave Creek district in 1911 was $30,693 in gold and a nominal quantity of silver. It was the most productive district in the county. In Jump Off Joe district the three productive hydraulic mines are the Cook and Howland, and the Swastika at Grants Pass, and the Sexton at Hugo post office. At Josephine Creek district the Canyon Creek, Gold Leaf, Flint Lock, Wilson & Anderson, and Jawbone hydraulic mines made a combined output of $6,978 in gold. There is only 1 small placer at Louse Creek district. The 2 productive hydraulic mines in Pickett Creek district are the Hell Gate and the Dutch Johnnie. The Horsehead Gulch hydraulic mine is the only productive mine in Williams Creek district. One mile north of Waldo, in Waldo district, the Deep Gravel mine has been doing extensive drift mining and some hydraulicking. The Logan mine was hydraulicked. The Osgood is also a hydraulic property. The gold output of this district in 1911 was $14,409. The Copper Knob, Ruble, and Jason hydraulic mines in Wolf Creek district made a combined output of $2,345 in gold.

### LANE COUNTY.

In 1911 Lane County produced 1,458.70 fine ounces of gold, valued at $30,154, and 466 ounces of silver, valued at $247, a total value of $30,401. In 1910 the county produced $4,054 in gold, and 67 ounces of silver, valued at $36. The increase in gold production for the year 1911 was $26,100, the largest in the State. The deep mines making this output were the Blue Bird and the Consolidated Lucky Boy at Blue River district, and the West Coast in Bohemia district. The Blue River has a Denver roller mill equal to 10-stamp capacity and tests were made for proper ore treatment during 1911. The West Coast Mines Co., with a 30-stamp mill, was by far the largest producer of the 3 mines named.

### MALHEUR AND WHEELER COUNTIES.

The total yield of Malheur County from 1 deep and 8 placer mines was $14,133 in gold, 126 ounces of silver, valued at $67, and copper the value of $1,291, a total of $15,491, as compared with $31,274 gold and 1,574 ounces of silver in 1910. The decrease in gold product was $17,141. The only deep mine is in Mormon Basin district. In the same district are the following productive hydraulic mines: Colt Bros., Johnson, Quartz Gulch, and Williams. In Ontario district is 1 small sluicing mine. In Wheeler County the total gold in 1911 was $2,962, with 28 ounces of silver, a total value of $7 from 2 hydraulic mines in Spanish Gulch district. In 1910 county made a production of $1,457 in gold and 15 ounces of , valued at $8. The increase in gold yield for 1911 was $1,505.

Deep m Sili Lea
Placer
Gr
a Blac
b Emr Resource
c A car
d Mine
e Miner vey from

## SOUTH DAKOTA.

By Charles W. Henderson.

### PRODUCTION.

The total value of the production of gold, silver, and lead in South Dakota for 1911, as reported from 37 productive mines, 17 of which were placers, amounted to $7,550,758. This is only slightly below the record of 1908, and as compared with $5,467,031 in 1910, shows an increase for 1911 of $2,083,727. The gold output was 359,903.90 fine ounces, valued at $7,439,874, almost 99 per cent of the total value. The increase in gold for the year was 98,569.72 fine ounces in quantity and $2,037,617 in value. The yield of silver also increased in proportion from 118,800 fine ounces to 203,755 fine ounces. Smelting ore from South Dakota in 1911 carried 64,311 pounds of lead, as against 14,136 pounds in 1910. No copper was recovered in 1911. Placer-gold production from 17 placers was 584.03 fine ounces, as compared with 143.77 fine ounces from 8 placers in 1910.

The total ore mined and treated in 1911 was 1,946,127 short tons, averaging 0.1846 ounce, or $3.817 in gold, as compared with 1,523,929 short tons, averaging $3.543 in 1910. There were 1,940,661 tons treated in the mills of the State, yielding as bullion $7,317,942 in gold and 172,598 fine ounces of silver, valued at $91,677, a total value of $7,409,619, or an average recovery per ton of $3.77 in gold and $0.05 in silver. Crude ore shipped to smelters amounted to 5,466 short tons, having an average content in gold of 0.959 ounce, or $19.84 per ton, and averaging $22.86 per ton in value of both gold and silver.

*Mine production of gold, silver, and lead in South Dakota in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 261,334.18 | $5,402,257 | 359,903.90 | $7,439,874 | 98,569.72 | $2,037,617 |
| Silver.....do.... | 118,800 | 64,152 | 203,755 | 107,990 | 84,955 | 43,838 |
| Lead.....pounds.. | 14,136 | 622 | 64,311 | 2,894 | 50,175 | 2,272 |
| Total..... | ..... | 5,467,031 | ..... | 7,550,758 | ..... | 2,083,727 |

The Homestake mines and mills were operated continuously in 1911, employing nonunion men. The operation of nearly all the other producing mines and mills was also continuous.

Chief amongst the developments for the year in the northern Black Hills were the nearing completion of the Homestake hydroelectric plant; the building at Galena of the new smelter and of the Gilt Edge-Maid concentrating plant; the development of its silver, sulphide ore body by the Golden Reward Co. and the proposed installation of a roaster at the mine; the open-cut mining and milling costs of the Wasp No. 2 Co.; the building of the 300-ton cyanide plant of the Bismarck Co. adjacent to the Wasp property; and the testing of the zinc deposits near Deadwood.

The operation for five and a half months of the first dredge in the Black Hills, at Mystic, Pennington County, was the chief feature of interest in the southern Black Hills.

*Tonnage of ore to gold and silver mills, with quantity of gold and silver contained in bullion produced in South Dakota in 1911, by processes.*

| Ore to gold and silver mills. | Process. | Gold in bullion. | Silver in bullion. |
|---|---|---|---|
| | | *Fine ounces.* | *Fine ounces.* |
| 1,940,661 short tons | Amalgamation | 221,409.39 | 67,310 |
| | Cyanidation | 132,596.08 | 105,288 |
| Total | | 354,005.47 | 172,598 |

*Consumption of quicksilver and cyanide in South Dakota mills in 1911.*

| Quicksilver. | Potassium cyanide. | Sodium cyanide. |
|---|---|---|
| *Pounds.* | *Pounds.* | *Pounds.* |
| [a] 13,800 | 144,350 | 455,495 |

[a] Represents 1 pound of mercury per 16.77 ounces of gold; or, 1 ounce of mercury per 1.05 ounces of gold; and 1 ounce of mercury per 6.88 tons of ore.

The following table shows the production of gold in South Dakota since the discovery of gold in that State in 1875:

*Production of gold in South Dakota since 1875.*

| | | | |
|---|---|---|---|
| 1876 [a] | $1,200,000 | 1895 [d] | $3,869,500 |
| 1877 [a] | 2,000,000 | 1896 [d] | 4,969,800 |
| 1878 [a] | 2,250,000 | 1897 [d] | 5,694,900 |
| 1879 [a] | 2,500,000 | 1898 [d] | 5,699,700 |
| 1880 [b] | 3,305,843 | 1899 [d] | 6,469,500 |
| 1881 [b] | 4,000,000 | 1900 [d] | 6,177,600 |
| 1882 [b] | 3,300,000 | 1901 [d] | 6,479,500 |
| 1883 [b] | 3,200,000 | 1902 [d] | 6,965,400 |
| 1884 [b] | 3,300,000 | 1903 [d] | 6,826,700 |
| 1885 [b] | 3,200,000 | 1904 [e] | 7,363,977 |
| 1886 [b] | 2,700,000 | 1905 [e] | 6,989,492 |
| 1887 [b] | 2,400,000 | 1906 [e] | 6,841,469 |
| 1888 [b] | 2,600,000 | 1907 [e] | 4,138,189 |
| 1889 [b] | 2,900,000 | 1908 [e] | 7,657,376 |
| 1890 [b] | [c] 3,200,000 | 1909 [e] | 6,577,836 |
| 1891 [b] | 3,550,000 | 1910 [e] | 5,402,257 |
| 1892 [b] | 3,700,000 | 1911 [e] | 7,439,874 |
| 1893 [d] | 4,006,400 | | |
| 1894 [d] | 3,868,155 | Total | 162,743,468 |

*Source of gold and silver production in South Dakota in 1911.*

| Source. | Number of mines. | Tonnage. | Gold. | | Silver. | | Total. |
|---|---|---|---|---|---|---|---|
| | | | Quantity. | Value. | Quantity. | Value. | |
| Deep mines: | | *Short tons.* | *Fine ounces.* | | *Fine ounces.* | | |
| Siliceous ore | 18 | 1,945,770 | 359,114.47 | $7,423,555 | 183,317 | $97,158 | $7,520,713 |
| Lead ore | 2 | 357 | 205.40 | 4,246 | 20,370 | 10,796 | 15,042 |
| Total | 20 | 1,946,127 | 359,319.87 | 7,427,801 | 203,687 | 107,954 | 7,535,755 |
| Placer mines | 17 | ..... | 584.03 | 12,073 | 68 | 36 | 12,109 |
| Grand total | 37 | 1,946,127 | 359,903.90 | 7,439,874 | 203,755 | 107,990 | 7,547,864 |

[a] Black Hills, S. Dak., by the Black Hills Mining Men's Association, 1904.
[b] Emmons, S. F., Progress of the precious-mineral industry in the United States since 1880; Mineral Resources United States for 1892, U. S. Geol. Survey, 1893, p. 71. Estimate of the Director of the Mint.
[c] A canvass of the mines by the Eleventh Census gives $3,091,137.
[d] Mineral Resources United States, U. S. Geol. Survey. Estimated by the Director of the Mint.
[e] Mineral Resources United States, U. S. Geol. Survey. Collected by the United States Geological Survey from the mines.

## REVIEW BY COUNTIES.

### CUSTER COUNTY.

There was a small output of placer gold from the vicinity of Custer, in Custer County, in 1911. A little development was done on several lode mines near Custer.

### LAWRENCE COUNTY.

*Mine production of gold, silver, and lead in Lawrence County, S. Dak., in 1910 and 1911.*

| Year. | Gold. | | Silver. | | Lead. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ozs.* | | *Fine ozs.* | | *Pounds.* | | |
| 1910 | 260,295.96 | $5,380,795 | 118,716 | $64,106 | 14,136 | $622 | $5,445,523 |
| 1911 | 358,379.25 | 7,408,356 | 203,350 | 107,775 | 64,311 | 2,894 | 7,519,025 |
| Increase | 98,083.29 | 2,027,561 | 84,634 | 43,669 | 50,175 | 2,272 | 2,073,502 |

Of the total State output, valued at $7,550,758, Lawrence County produced $7,519,025. The yield by metals was $7,408,356 for gold, 203,350 fine ounces of silver, and 64,311 pounds of lead. All the large mines of the State are in this county.

During 1911 there were 1,940,719 short tons of ore treated (practically all siliceous) from 12 deep mines, with an average value per ton of $3.82 in gold and of $0.06 in silver, as compared with 15 mines in 1910, with an output of 1,522,896 short tons and an average value per ton of $3.53 in gold and of $0.042 in silver. In 1911 there were treated in the mills of the county 1,935,350 tons, which yielded to the amalgamating plates and cyanide treatment $7,301,851 in gold and 172,282 fine ounces of silver, valued at $7,393,160, at an average value per ton in gold of $3.77 and in gold and silver of $3.82. To smelters outside the State were sent 5,369 tons, containing $105,424 in gold, and 31,060 fine ounces of silver, with a total value of $121,886, at an average value per ton of $19.64 in gold and $22.70 in gold and silver. Smelters also recovered 64,311 pounds of lead from ores from this county.

The output of placer gold from four placers decreased. Most of the placer yield came from near Tinton, Rawlings district, the rest from Whitewood.

At the Homestake mine, which produces the bulk of the gold bullion from this State, at the beginning of the year the labor difficulties of 1909–1910 had been completely overcome and operations were again at the full capacity of the plant of 1,000 stamps, with cyanide, sand, and slime plants. The Homestake Co. has issued a public report [1] covering 19 months' operation, from June 1, 1910, to December 31, 1911. The report shows the following for the year ended June 1, 1911:

Ore milled, 1,468,263 tons; recovery, $5,251,454; per ton, $3.5766; dividends, $1,310,400; hydroelectric plant expenditure, $393,088; net loss, $397,537. For the seven months ended December 31, 1911: Ore milled, 888,057 tons; recovery, $3,661,152; per ton, $4.1205; dividends, $764,400; hydroelectric plant expenditure, $231,134;

[1] Min. and Sci. Press, Apr. 20, 1912, p. 576; also Eng. and Min. Jour., Mar. 23, 1912, p. 593.

surplus, $414,261. There is broken in the stopes 1,883,277 tons, and there is enough blocked out and unbroken ore to supply the 1,000 stamps for 20 years.

The hydroelectric installation was completed early in 1912, and on April 11, 1912, the power operation of the Amicus 240-stamp mill was changed from steam to electricity.

In the Bald Mountain area, the mines were operated steadily. The oxidized ore from the Golden Reward group was milled at the company's plant and sulphide ore was shipped to smelters. The New Reliance Co. changed its mill from 4 Huntington mills and rolls to 20 stamps, and operated from July 1, after reconstructing the mill. The Lundberg, Dorr & Wilson mill was operated on ores from the company's Buxton and Bonanza properties, and also on those from the Trojan, and from Bertschy's lease on the McGovern mine of the Imperial property. Crude ore to smelters at Omaha and Denver was also shipped from the Trojan and the McGovern mines.

In the Bear Butte (or Galena) district, lead ore was shipped from the Richmond-Sitting Bull property. The Gilt Edge Consolidated Mines Co. was engaged in the construction of a 250-ton concentration mill for the concentration of its pyritous ore, the concentrates to be shipped to the new smelter being erected by the Black Hills Smelting Co. Development work was done on the Bristol mine.

The Black Hills Development & Financial Co. shipped lead ore from its property in the Carbonate district.

Development work was done by the Minnesota and North Homestake Cos., in the Maitland district.

The 500-ton, dry crushing, cyanide plant of the Wasp No. 2 Mining Co., in the Yellow Creek area, was operated continuously. The public annual report of the company shows that during 1911 the mine produced 160,860 tons of ore, which yielded in the mill $286,160, or an average of $1.78 per ton.[1] The Bismarck Consolidated Mines Co., in the same district, was engaged in opening its mine and in building a 300-ton mill.

## REDUCTION MILLS.

*List of reduction mills in Lawrence County, S. Dak., in 1911.*

MILLS IN OPERATION.

| Company. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|
| | | | *Short tons.* |
| Golden Reward | Cyanidation | Gates crusher, rolls, Chilean mills, sand tanks, slimes to Moore process, 4 Dorr thickeners. | 200 |
| Homestake | Amalgamation and cyanidation. | 6 wet-crushing stamp mills aggregating 1,000 stamps, 2 cyanide sand plants, 1 cyanide slime plant, 2 Dorr classifiers, and 2 thickeners. | 4,200 |
| Lundberg, Dorr & Wilson. | Cyanidation | Chilean mill, sand tanks, slimes to Moore process, 2 Dorr classifiers, and thickener. | 100 |
| Mogul | do | Crushing, leaching sands, slimes to Moore process, 5 Dorr classifiers, and 3 thickeners. | 400 |
| New Reliance | do | Changed from 4 Huntington mills and rolls to 20 stamps, Dorr classifier, and 4 thickeners. | 100 |
| Trojan | do | Gates crusher, Eclipse rolls, Monadnock mills, Dorr classifier, thickener, sand tanks, stationary leaf filter. | 200 |
| Wasp No. 2 | do | Steam shovel for stripping, Gates crushers, McFarlane rolls, leaching tanks. | 500 |

[1] Min. and Sci. Press, Feb. 24, 1911, p. 320.

*List of reduction mills in Lawrence County, S. Dak., in 1911*—Continued.

MILLS UNDER CONSTRUCTION.

| Company. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|
| | | | *Short tons.* |
| Bismarck | Cyanidation | | 300 |
| Gilt Edge-Maid | Concentration | | 250 |

MILLS IDLE.

| | | | |
|---|---|---|---|
| Branch Mint | Cyanidation | 180 (?) stamps | |
| Gilt Edge-Maid | do | | 200 |
| Golden Crest | do | 40 stamps, 3 Dorr classifiers, 2 Dorr thickeners, tube mill, all sliming, Moore filter process. | 200 |
| Gordelia | Amalgamation | 10 stamps | 50 |
| Hidden Fortune | Cyanidation | | 100 |
| Imperial | do | 30 stamps | 100 |
| Lucky Strike | do | | 150 |
| Minnesota | do | 2 roughing rolls, 2 slow-speed Chilean mills. | 150 |
| North Homestake | do | 40 stamps | 140 |
| Pluma (2 old mills) | Amalgamation and cyanidation. | 40 and 60 stamps | 160 and 240 |
| Puritan | Concentration and cyanidation. | 20 stamps, 2 Dorr classifiers, etc | 240 |
| Victoria Extension | Cyanidation | | 200 |

## PENNINGTON COUNTY.

There were 8 producing deep mines and 8 placers in Pennington County in 1911. The placer output again increased greatly. The total value of the county output in gold and silver, from both deep and placer mines, was $31,422.

Near Mystic, on Castle Creek, the Castle Creek Hydraulic Gold Mining Co. operated from June to November the first dredge in the Black Hills. A trial run of the Hymalulu mill was made during the year.

At Hill City some ore from the Golden Slipper mine was milled in the 5-stamp mill on the property.

At Keystone ore from the Bismarck and the Columbia mines was milled at amalgamating plants. Some crude ore was also shipped to smelters from the Columbia mine. A little placer gold was recovered near Keystone.

At Oreville considerable gold bullion was produced at the 10-stamp amalgamation mill of the Clara Belle property.

At Pactola a small but increased quantity of placer gold was recovered by drifting and sluicing.

## TEXAS.

By Charles W. Henderson.

### PRODUCTION.

The following table shows the production of gold, silver, copper, and lead in Texas in 1910 and 1911:

*Production of gold, silver, copper, and lead in Texas in 1910 and 1911.*

| Year. | Gold. | | Silver. | | Copper. | | Lead. | | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ozs.* | | *Fine ozs.* | | *Pounds.* | | *Pounds.* | | |
| 1910 | 20.46 | $423 | 380,322 | $205,374 | 3,157 | $401 | 65,068 | $2,863 | $209,061 |
| 1911 | 1.02 | 21 | 424,394 | 214,929 | ..... | ..... | 122,800 | 5,526 | 220,476 |
| Increase (+) or decrease (−). | −19.44 | −402 | +44,072 | +9,555 | −3,157 | −401 | +57,732 | +2,663 | +11,415 |

The total value of the mine production in Texas in 1911 was $220,476, an increase of $11,415. The yield of silver, which represents over 97 per cent of the State mine production, was 424,394 fine ounces, valued at $214,929, an increase of 44,072 fine ounces in quantity and of $9,555 in value. The yield of lead was 122,800 pounds, as compared with 65,068 pounds in 1910. The greater part of the output was from the Shafter district, Presidio County.

#### CULBERSON COUNTY.

The mining districts of this county were formerly in El Paso County. No production was made from the mines near Van Horn.

#### EL PASO COUNTY.

No production was made from the mines near Lasca and Sierra Blanca. At the Bonanza mine operations are in prospect, some lead and zinc ore being reported as shipped in 1912. Ore from the Hazel [1] mine was tested and a concentrating plant was under construction.

#### KNOX COUNTY.

Some development work was done on the Pyron copper prospect, near Truscott. The ore is found as chalcocite in the blue clays of the Permian [2] beds. Some copper ore was mined from the Harris & Harkins mine, in Permian beds, near Knox, but none was shipped.

[1] Richardson, G. B., Reconnaissance of trans-Pecos Texas: Bull. Univ. Texas Mineral Survey No. 9, 1904, pp. 24–25.

[2] Cummins, W. F., Notes on the geology of northwest Texas: Fourth Ann. Rept. Geol. Survey Texas, 1893, pp. 232–238.

### LLANO COUNTY.[1]

The Heath mine of the Llano Gold & Rare Metal Mining Co., near Llano, is opened by workings consisting of a 628-foot vertical shaft, 250-foot incline shaft, four 65-foot vertical shafts, and 200 feet of open cuts. The newly completed 50-ton mill, with equipment of Chilean mill, amalgamation plates, and 2 Wilfley tables, was put in operation in January, 1912. Prospecting was continued on the Boyd & Roberts mine, near Llano.

### PRESIDIO COUNTY.

*Candelaria district.*—Some lead ore was shipped in 1911.

*Shafter district.*[2]—The Presidio mine, in this district, is the principal producer in Texas. It is opened to a depth of 700 feet by one shaft and of 200 feet by another. Considerable development work was done in 1911. The ore bodies are for the most part confined to the Cibolo limestone of the Carboniferous.[3] The ore, which is chiefly silver chloride (horn silver), with which are associated more or less isolated patches of silver-bearing galena, is crushed by stamps, 15 in number, which is followed by pan amalgamation, with sulphate of copper, salt, and quicksilver. During the last few years only, the lead in the ore has been recovered by concentrating over Wilfley tables, by re-treatment of the tailings, but this work was stopped early in 1911. The ore is almost entirely free from zinc, but the concentrates produced carried a small quantity of this metal.

## UTAH.

By V. C. Heikes.

### PRODUCTION.

For the calendar year 1911 the production of gold, silver, copper, lead, and zinc in Utah from 7,268,530 tons of ore and a small placer output was valued at $36,837,457, an increase of $4,638,272, as compared with 6,389,398 tons of ore in quantity and $32,199,184 in value from deep mines and a nominal placer output in 1910. Mine operators of 208 properties, 8 of which were placers, shipped ore and bullion, as against 175 lode mines and 8 placers in 1910. About one-half of the total value for 1911 represented the copper production, which was valued at $18,370,103, an increase of $2,165,275, as compared with the production of 1910. The other metal outputs also show substantial increases. Mines in Salt Lake, Beaver, Summit, and Juab counties yielded an increased output of ore. The production of Beaver County increased in copper and gold and that of Juab County gained in all metals except lead. Salt Lake County had the greatest total value for its metal output, which increased from $18,981,177 in 1910 to $22,561,615 in 1911. Concentrates recovered from ores at milling plants contained over 22 per cent of the gold,

[1] Paige, Sidney, Mineral resources of the Llano-Burnet region, Texas: Bull. U. S. Geol. Survey No. 450, 1911. Comstock, T. B., Report on the geology and mineral resources of the central region of Texas: Second Ann. Rept. Geol. Survey Texas, 1891, pp. 577–582. Also a preliminary report on the geology of the central mineral region of Texas: First Ann. Rept. Geol. Survey Texas, 1890, pp. 334–339.

[2] Phillips, William B., Shafter silver district, Presidio County, Tex.: Eng. and Min. Jour., Dec. 31, 1910, p. 1303.

[3] Udden, J. A., The geology of the Shafter silver mine district, Presidio County, Tex.: Bull. Univ. Texas Mineral Survey No. 8, 1904, p. 54.

19.8 per cent of the silver, 73 per cent of the copper, over 34 per cent of the lead, and 74 per cent of the zinc and were valued at $18,633,465, or an average value of $52.14 per ton. Crude ores shipped directly to smelters yielded 63.8 per cent of the gold, 79 per cent of the silver, 26.3 per cent of the copper, 65.6 per cent of the lead, and 26.2 per cent of the zinc, in all valued at $17,364,933, or an average value of $15.74 per ton. By the amalgamation and cyanidation processes 13.4 per cent of the gold and 0.9 per cent of the silver was recovered, valued at $686,230, or an average of $2.57 per ton. The placer production of gold increased and was valued at $5,634, as against $3,980 reported in 1910. The variation in the metallic production of Utah during 1910 and 1911 is shown in the following table:

*Mine production of gold, silver, copper, lead, and zinc in Utah, in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 195,052.11 | $4,032,085 | 227,217.28 | $4,696,998 | 32,165.17 | $664,913 |
| Silver.....do.... | 10,466,971 | 5,652,164 | 12,473,787 | 6,611,107 | 2,006,816 | 958,943 |
| Copper.....pounds.. | 127,597,072 | 16,204,828 | 146,960,827 | 18,370,103 | 19,363,755 | 2,165,275 |
| Lead.....do.... | 123,324,635 | 5,426,284 | 136,496,750 | 6,142,354 | 13,172,115 | 716,070 |
| Zinc.....do.... | 16,367,104 | 883,824 | 17,840,261 | 1,016,895 | 1,473,157 | 133,071 |
| Total..... | ..... | 32,199,185 | ..... | 36,837,457 | ..... | 4,638,272 |

Statistics of the annual production since 1904 are shown in the table following:

*Quantity of ore sold or treated in Utah in 1904–1911, and total content of gold, silver, copper, lead, and zinc.*

| Year. | Quantity. | Gold.[a] | Silver.[a] | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1904..... | 1,716,947 | 202,675.00 | 12,049,446 | 46,417,234 | 116,479,764 | 73,439 | $21,989,415 |
| 1905..... | 2,181,061 | 248,692.00 | 11,036,471 | 57,298,054 | 103,882,009 | 3,330,327 | 25,824,387 |
| 1906..... | 2,348,819 | 252,439.43 | 11,550,634 | 56,593,576 | 125,342,836 | 6,474,615 | 31,419,365 |
| 1907..... | 2,669,696 | 247,759.63 | 10,990,076 | 64,256,884 | 115,938,037 | 5,452,916 | 31,692,911 |
| 1908..... | 3,658,957 | 179,054.60 | 8,451,338 | 86,843,812 | 88,777,498 | 1,460,554 | 23,441,280 |
| 1909..... | 5,122,589 | 203,491.76 | 11,717,172 | 108,947,811 | 148,486,463 | 9,860,778 | 31,380,092 |
| 1910..... | 6,389,398 | 195,052.11 | 10,466,971 | 127,597,072 | 123,324,635 | 16,367,104 | 32,199,184 |
| 1911..... | 7,268,530 | 227,217.28 | 12,473,787 | 146,960,827 | 136,496,750 | 17,840,261 | 36,837,457 |

[a] Includes a very small placer production.

## ORE PRODUCTION IN 1911.

The deepening of Utah lead mines is affording a steadily increasing quantity of heavy sulphides, while the lack of new lead deposits has lessened the supply of carbonate ores, and the smelters have had to provide additional roasting capacity to prepare this increased sulphide tonnage for the furnaces. The magnitude of Utah's output is largely influenced by the production of porphyry copper ore at Bingham and near Newhouse. The total ore sold or treated in 1911 amounted to 7,268,530 tons, which included small quantities of old slag sortings and old tailings re-treated. Compared with the production of 1910, the total increased 879,132 tons in quantity;

the total value per ton rose from $5.04 to $5.07; and the gold and silver value from $1.52 to $1.55 per ton. The increase in tonnage was largest in copper ores and important in all other ores with the exception of copper-lead ore. The output of dry or siliceous ore increased from 391,568 tons in 1910 to 464,229 tons in 1911. Under this classification is included 331,433 tons of dry or siliceous gold and silver ores, averaging per ton $3.61 in gold, 1.75 ounces of silver, 6.8 pounds of copper, and 5 pounds of lead, with a total average value of $5.64 per ton. Three-fourths of the siliceous ore contained gold as the predominating metal and was produced from the Mercur mines in the Camp Floyd district, in Tooele County. The siliceous silver ores aggregated 92,520 tons and averaged per ton $4.44 in gold, 21.21 ounces of silver, 10.6 pounds of copper, and 11.7 pounds of lead, with an average value of $17.55. These ores of silver were produced principally in the Tintic district, and smaller quantities came from Bingham and Park City. Oxidized iron-manganese ores, carrying very small quantities of gold and silver, were produced in the Tintic district, in Juab County; near Marysvale, in Piute County; and in Morgan County. The yield of 40,276 tons contained an estimated average per ton of 41 cents in gold, 0.6 ounce of silver, and traces of copper and lead. The copper ore mined aggregated 6,121,099 tons and contained 41 cents in gold, 0.39 ounce of silver, 22.77 pounds of copper, and a trace of lead, and was valued at $3.45 per ton. Nearly 90 per cent of the copper ore, or 5,478,366 tons, was from the low-grade porphyry deposits at Bingham and Newhouse, and averaged per ton 16 cents in gold, 0.074 ounce of silver, and 19.36 pounds of copper. All the porphyry copper ore was concentrated and the concentrates were smelted. The remainder of the copper ore, consisting principally of sulphides of copper and iron, was shipped directly to the smelters. About 15 per cent more lead ore was produced in 1911 than in 1910, making the production reach 393,079 tons, which contained an average of $1.35 in gold, 15.48 ounces of silver, 7.34 pounds of copper, and 248.02 pounds of lead, averaging in total value $21.63 per ton. Sulphide lead ore predominated and most of it was of concentrating grade. The remainder was carbonate lead ore, which was shipped with higher grade sulphides directly to the smelter. The Park City region and Bingham produce nearly all of the lead ores of concentrating grade. Production of copper-lead ores, mostly sulphides, decreased from 14,982 tons in 1910 to 3,553 tons in 1911. Its average metal content in 1911 was 67 cents in gold, 23.63 ounces of silver, 89.32 pounds of copper, 224.10 pounds of lead, and its average value $34.44 per ton. The lead-zinc ore produced aggregated 280,817 tons in 1911 against 231,278 tons in 1910. The average metallic content of the output of 1911 was 37 cents in gold, 4.84 ounces of silver, 3.97 pounds of copper, 124.99 pounds of lead, and 59.39 pounds of zinc, with an average value of $12.43 per ton. A little less than 3 per cent of this ore was shipped directly to zinc refiners, and the remainder was concentrated. Zinc ore from Summit and Tooele counties aggregated 5,753 tons in 1911, as against an output of 4,954 tons in 1910. The average metallic content of the output of 1911 was 1.67 pounds of lead, 202.51 pounds of zinc, and a trace of gold, silver, and copper, having in all an average value of $11.68 per ton.

*Output of ore and production of metals in Utah in 1911, by kinds of ore.*

| Source of production. | Number of producers. | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Placers | 8 | ..... | 272.54 | 33 | ..... | ..... | ..... |
| Siliceous ore | 45 | 464,229 | 78,912.69 | 2,569,157 | 3,259,690 | 2,757,084 | ..... |
| Copper ore | 38 | 6,121,099 | 117,247.94 | 2,377,946 | 139,382,161 | 338,688 | ..... |
| Lead ore | 122 | 393,079 | 25,709.04 | 6,083,877 | 2,885,369 | 97,494,377 | ..... |
| Zinc ore | 6 | 5,753 | 1.60 | 491 | 478 | 9,601 | 1,165,064 |
| Copper-lead ore | 17 | 3,553 | 114.16 | 83,972 | 317,359 | 796,237 | ..... |
| Lead-zinc ore | 14 | 280,817 | 4,959.31 | 1,358,311 | 1,115,770 | 35,100,763 | 16,675,197 |
| Total | ..... | 7,268,530 | 227,217.28 | 12,473,787 | 146,960,827 | 136,496,750 | 17,840,261 |

*Subdivision of tonnage, by kinds, of ore sold or treated from Utah in 1911, by counties, in short tons.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|
| Beaver | 2,010 | 245,817 | 11,533 | ..... | 74 | 261 | 259,695 |
| Boxelder | 1,800 | 1,518 | 161 | ..... | 38 | ..... | 3,517 |
| Garfield | 100 | ..... | ..... | ..... | ..... | ..... | 100 |
| Grand | ..... | 6 | ..... | ..... | ..... | ..... | 6 |
| Iron | 202 | ..... | ..... | ..... | ..... | ..... | 202 |
| Juab | 179,372 | 69,038 | 52,841 | ..... | 56 | 19 | 301,326 |
| Millard | 43 | ..... | 34 | ..... | ..... | ..... | 77 |
| Morgan | ..... | ..... | 26 | ..... | ..... | ..... | 26 |
| Piute | 3,050 | 108 | ..... | ..... | ..... | ..... | 3,158 |
| Salt Lake | 14,281 | 5,804,542 | 133,346 | ..... | 2,641 | 96,232 | 6,051,042 |
| Sevier | 1,291 | ..... | ..... | ..... | ..... | ..... | 1,291 |
| Summit | 4,236 | ..... | 102,682 | 4,437 | ..... | 125,512 | 236,867 |
| Tooele | 256,337 | 70 | 25,754 | 1,316 | 736 | 6,918 | 291,131 |
| Utah | 1,507 | ..... | 59,094 | ..... | 8 | ..... | 60,609 |
| Wasatch | ..... | ..... | 7,608 | ..... | ..... | 51,875 | 59,483 |
| Total | [a] 464,229 | 6,121,099 | 393,079 | 5,753 | 3,553 | 280,817 | 7,268,530 |
| Value per ton in gold and silver | $6.45 | $0.60 | $9.55 | $0.05 | $13.19 | $2.93 | $1.55 |

[a] 331,433 tons siliceous gold and silver ores; 92,520 tons silver ores; 40,276 tons oxidized gold and silver bearing iron-manganese ores.

## GOLD.

Gold was produced from ores mined in 17 counties. This includes the small placer yield in 3 of the counties. The total gold production was 227,217.28 ounces, valued at $4,696,998 in 1911, against 195,052.11 ounces, valued at $4,032,085 in 1910. The largest decreases were made in Tooele, Utah, and 8 other counties, but the decrease was fully offset by an increase in Salt Lake and Juab counties. The increase was due to the greater production of copper ores in the former county and the siliceous ores in the latter. Milling of the gold ores by amalgamation was carried on in Beaver, Boxelder, Garfield, Piute, and Salt Lake counties, one plant in each county. The cyanidation of ores containing gold was carried on in Tooele (Mercur district), Piute (Gold Mountain district), and Iron (Gold Springs district) counties. The process is also used at Bingham, in Salt Lake County, on a siliceous silver ore, containing a little gold, mined by lessees from the Telegraph mine. The gold bullion produced from these two processes in Utah contained $626,609 in gold from the treatment of 267,111 tons of ore and 4,600 tons of old tailings, from which the average recovery was $2.53 per ton. The gold extracted

by amalgamation averaged $3.23 per ton treated, and by cyanidation $2.29 per ton. Gold that was contained in the copper, lead, zinc, and copper-lead concentrates amounted to 50,225.12 ounces. The copper concentrates contained the largest quantity, or 42,589.23 ounces of gold; the lead concentrates 7,568.01 ounces; zinc concentrates, 64.12 ounces; and copper-lead concentrates, 3.76 ounces. The gold yield from placer mining increased from $3,980 in 1910 to $5,634 in 1911. Placers in Garfield, San Juan, and Uinta counties were slightly productive in 1911.

*Source of gold production of Utah, by kinds of ores, in 1911, by counties, in fine ounces.*

| County. | Placers. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|---|
| Beaver | | 399.13 | 1,582.24 | 315.62 | | 0.72 | 3.39 | 2,301.10 |
| Boxelder | | 294.38 | .03 | 6.00 | | | | 300.41 |
| Garfield | 52.20 | 39.82 | | | | | | 92.02 |
| Grand | | | .10 | | | | | .10 |
| Iron | | 86.79 | | | | | | 86.79 |
| Juab | | 47,205.53 | 19,205.88 | 6,153.02 | | 15.44 | | 72,579.87 |
| Millard | | 58.28 | | .45 | | | | 58.73 |
| Morgan | | | | .29 | | | | .29 |
| Piute | | 1,189.56 | 66.64 | | | | | 1,256.20 |
| Salt Lake | | 1,730.06 | 96,393.05 | 8,749.33 | | 84.58 | 3,576.66 | 110,533.68 |
| San Juan | 52.00 | | | | | | | 52.00 |
| Sevier | | 6.43 | | | | | | 6.43 |
| Summit | | 295.20 | | 2,680.02 | 1.60 | | 919.21 | 3,896.03 |
| Tooele | | 27,576.65 | | 706.28 | | 12.42 | | 28,295.36 |
| Uinta | 168.34 | | | | | | | 168.34 |
| Utah | | 30.86 | | 6,509.99 | | 1.00 | | 6,541.85 |
| Wasatch | | | | 588.04 | | | 460.05 | 1,048.09 |
| Total | 272.54 | [a] 78,912.69 | 117,247.94 | 25,709.04 | 1.60 | 114.16 | 4,959.31 | 227,217.28 |

[a] 58,204.33 ounces contained in siliceous gold and silver ores; 19,941.87 ounces in silver ores; 766.51 ounces in oxidized gold and silver bearing iron-manganese ores.

## SILVER.

The silver produced from Utah mines increased from 10,466,971 ounces, valued at $5,652,164, in 1910, to 12,473,787 ounces, valued at $6,611,107, in 1911. In 1909 the output was 11,717,172 ounces. Mines in Juab, Salt Lake, Summit, Utah, and Wasatch counties yielded the larger part of the silver from lead-silver ore. Concentrates produced at milling plants yielded 2,478,012 ounces of silver. Low-grade copper ores yielded 228,591 tons of copper concentrates, containing 431,405 ounces, or about 17 per cent, of the total silver produced from concentrates, averaging 1.89 ounces per ton. Lead concentrates from low-grade lead ore contained 1,915,322 ounces of silver, or an average of 17.90 ounces per ton; zinc concentrates, 5.69 ounces per ton; and copper-lead concentrates, 31 ounces per ton. Silver in bullion produced from ores and tailings treated by amalgamation aggregated 1,029 ounces, and by cyanidation 111,464 ounces. Crude ore shipped to smelters yielded 9,859,665 ounces, or nearly four-fifths of the total silver output, from five kinds of ore, the dry or siliceous ore yielding 2,451,673 ounces, or an average of 12.94 ounces per ton; copper ore yielding 1,926,406 ounces, or an average of 3.01 ounces per ton; lead ore, 5,400,455 ounces, or an average of 20.66 ounces per ton; copper-lead ore, 72,849 ounces, or an average of 32.83 ounces per ton; and lead-zinc ore, 8,282 ounces, or an average of 1.03 ounces per ton.

*Source of silver production of Utah, by kinds of ore, in 1911, by counties, in fine ounces.*

| County. | Placers. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|---|
| Beaver | ..... | 24,898 | 31,740 | 140,611 | ..... | 1,396 | 2,614 | 201,259 |
| Boxelder | ..... | 59 | 214 | 1,486 | ..... | 532 | ..... | 2,291 |
| Garfield | 9 | 11 | ..... | ..... | ..... | ..... | ..... | 20 |
| Grand | ..... | ..... | 360 | ..... | ..... | ..... | ..... | 360 |
| Iron | ..... | 1,012 | ..... | ..... | ..... | ..... | ..... | 1,012 |
| Juab | ..... | 2,321,617 | 871,012 | 1,480,180 | ..... | 889 | ..... | 4,673,698 |
| Millard | ..... | 800 | ..... | 105 | ..... | ..... | ..... | 905 |
| Morgan | ..... | ..... | ..... | 149 | ..... | ..... | ..... | 149 |
| Piute | ..... | 2,259 | 3,134 | ..... | ..... | ..... | ..... | 5,393 |
| Salt Lake | ..... | 122,133 | 1,471,171 | 1,031,398 | ..... | 62,876 | 259,903 | 2,947,481 |
| San Juan | 12 | ..... | ..... | ..... | ..... | ..... | ..... | 12 |
| Sevier | ..... | 1,291 | ..... | ..... | ..... | ..... | ..... | 1,291 |
| Summit | ..... | 90,889 | ..... | 1,993,589 | 491 | ..... | 797,856 | 2,882,825 |
| Tooele | ..... | 3,710 | 315 | 254,534 | ..... | 17,926 | ..... | 276,485 |
| Uinta | 12 | ..... | ..... | ..... | ..... | ..... | ..... | 12 |
| Utah | ..... | 478 | ..... | 933,937 | ..... | 353 | ..... | 934,768 |
| Wasatch | ..... | ..... | ..... | 247,888 | ..... | ..... | 297,938 | 545,826 |
| Total | 33 | [a] 2,569,157 | 2,377,946 | 6,083,877 | 491 | 83,972 | 1,358,311 | 12,473,787 |

[a] 581,878 ounces contained in siliceous gold and silver ores; 1,962,527 ounces in silver ores; 24,752 ounces in gold and silver bearing oxidized iron-manganese ores.

## COPPER.

Utah's output of copper in 1911 amounted to 146,960,827 pounds, valued at $18,370,103, an increase of 19,363,755 pounds, four-fifths of which was the result of the increased tonnage of copper ore mined at Bingham, with the remainder of the increase credited to Juab and Beaver counties. Concentrates recovered at milling plants in Utah contained 107,390,325 pounds of copper, and crude ore shipped to smelters, 38,764,871 pounds. Copper concentrates yielded 72.1 per cent of the State total, or 105,951,588 pounds, and averaged 463.5 pounds of copper per ton. Lead concentrates contained 1,394,266 pounds of copper, averaging 13 pounds per ton; zinc concentrates contained 15,117 pounds; and copper-lead concentrates, 29,354 pounds, or 100.8 pounds per ton. The crude copper ores smelted were largely sulphides and contained 32,637,950 pounds, or an average of 50.94 pounds per ton; lead ores, 2,587,717 pounds, or an average of 9.90 per ton; copper-lead ores, 278,772 pounds, or 125.63 pounds per ton; and lead-zinc ores, 4,092 pounds, or an average of 0.51 pound per ton.

*Source of copper production of Utah, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|
| Beaver | 17,861 | 3,589,972 | 124,811 | ..... | 6,638 | ..... | 3,739,282 |
| Boxelder | ..... | 285,906 | 503 | ..... | 3,360 | ..... | 289,769 |
| Grand | ..... | 342 | ..... | ..... | ..... | ..... | 342 |
| Iron | 3 | ..... | ..... | ..... | ..... | ..... | 3 |
| Juab | 3,207,308 | 7,485,990 | 228,078 | ..... | 5,724 | ..... | 10,927,100 |
| Millard | 1,342 | ..... | 69 | ..... | ..... | ..... | 1,411 |
| Piute | ..... | 7,816 | ..... | ..... | ..... | ..... | 7,816 |
| Salt Lake | 31,075 | 127,980,689 | 1,803,270 | ..... | 227,567 | 370,371 | 130,412,972 |
| Summit | 2,101 | ..... | 367,370 | 478 | ..... | 591,173 | 961,122 |
| Tooele | ..... | 31,446 | 188,120 | ..... | 73,540 | ..... | 293,106 |
| Utah | ..... | ..... | 7,306 | ..... | 530 | ..... | 7,836 |
| Wasatch | ..... | ..... | 165,842 | ..... | ..... | 154,226 | 320,068 |
| Total | [a] 3,259,690 | 139,382,161 | 2,885,369 | 478 | 317,359 | 1,115,770 | 146,960,827 |

[a] 2,260,868 pounds contained in siliceous gold and silver ores; 983,235 pounds in silver ores; 15,587 pounds in gold and silver bearing oxidized iron-manganese ores.

## LEAD.

An increase in the lead production from 123,324,635 pounds, valued at $5,426,284 in 1910, to 136,496,750 pounds, valued at $6,142,354 in 1911, was due principally to the increased output of lead ore of the mines at Bingham, containing 46,576,337 pounds in 1911, against an output of 30,271,016 pounds in 1910. In the Park City region the gain in lead was also important, increasing from 38,129,761 pounds in 1910 to 47,637,642 pounds in 1911. The increases in the two districts more than offset the large decrease of the Tintic district from 37,553,445 pounds in 1910 to 23,572,966 pounds in 1911. Beaver County mines did not produce so much lead ore in 1911 as in 1910, thereby decreasing the lead output from 6,235,525 pounds to 4,534,678 pounds. The total crude ore of shipping grade contained 89,591,550 pounds of lead. Ninety-four per cent of this lead was the content of 261,333 tons of ore, principally sulphide and some carbonate, averaging 322.36 pounds of lead per ton. The copper-lead sulphide ore, aggregating 2,219 tons, and 8,033 tons of zinc-lead carbonate ore carried, respectively, 328.09 pounds and 215.56 pounds of lead per ton. The copper-lead ore was reduced to bullion at lead smelters, and the metals of the zinc-lead ore are reported to have been converted into pigment. A small tonnage of copper ores contained lead, and although treated at lead furnaces they were more valuable for the gold and silver content than for either of the base metals. The dry or siliceous ores, which were sold to lead smelters for their gold and silver content, carried a small quantity of lead. Part of this ore went to copper furnaces, where the lead is lost in smelting and is therefore eliminated from tabulation. Concentrates, mostly sulphides, were shipped to the smelters and contained 46,847,841 pounds of lead, of which 45,702,551 pounds, averaging 21.35 per cent of metal in concentrates, came from lead concentrate; 1,099,418 pounds, averaging 2.56 per cent, from zinc concentrate; and 45,872 pounds, averaging 7.88 per cent, from copper-lead concentrate. Lead contained in dry or siliceous ores averaged 5 pounds per ton; in copper ores, 0.05 pound per ton; in lead ores, 248.02 pounds per ton; in zinc ores, 1.67 pounds per ton; in copper-lead ores, 224.10 pounds per ton; and in lead-zinc ores, 124.99 pounds per ton. The copper ores containing lead in greatest quantity were produced in Juab, Salt Lake, Beaver, and Grand counties.

*Source of lead production of Utah, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Zinc ore. | Copper-lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|---|
| Beaver | 27,687 | 757 | 4,434,357 | ..... | 11,236 | 60,641 | 4,534,678 |
| Boxelder | ..... | ..... | 60,505 | ..... | 9,880 | ..... | 70,385 |
| Grand | ..... | 236 | ..... | ..... | ..... | ..... | 236 |
| Juab | 2,484,906 | 335,121 | 12,174,288 | ..... | 15,213 | 5,956 | 15,015,484 |
| Millard | ..... | ..... | 15,155 | ..... | ..... | ..... | 15,155 |
| Morgan | ..... | ..... | 16,890 | ..... | ..... | ..... | 16,890 |
| Salt Lake | 241,378 | 2,574 | 35,122,759 | ..... | 447,581 | 11,833,098 | 47,647,390 |
| Summit | 3,088 | ..... | 22,300,835 | 9,601 | ..... | 15,423,384 | 37,736,908 |
| Tooele | ..... | ..... | 9,971,745 | ..... | 302,992 | 1,472,060 | 11,746,797 |
| Utah | 25 | ..... | 9,802,733 | ..... | 9,335 | ..... | 9,812,093 |
| Wasatch | ..... | ..... | 3,595,110 | ..... | ..... | 6,305,624 | 9,900,734 |
| Total | [a] 2,757,084 | 338,688 | 97,494,377 | 9,601 | 796,237 | 35,100,763 | 136,496,750 |

[a] 1,662,819 pounds contained in siliceous gold and silver ores; 1,079,435 pounds in silver ores; 14,830 pounds in gold and silver bearing oxidized iron-manganese ores.

### ZINC.

After concentration and smelting losses are accounted for, the zinc production of Utah from ore and concentrate aggregated 17,840,261 pounds, figured as spelter, valued at $1,016,895, in 1911, against a production in 1910 of 16,367,104 pounds, valued at $883,824. From 21,482 tons of zinc concentrates 13,156,682 pounds of spelter were recovered, or 30.62 per cent of the zinc concentrate; and from 9,349 tons of crude ore 4,683,579 pounds of spelter were recovered. Zinc ore averaged 33.35 per cent of metal, and lead-zinc ore averaged 23.69 per cent. The largest quantities of zinc contained in concentrate was produced in the Park City region, which, in 1911, yielded 8,596,564 pounds, less by 841,428 pounds than was produced in 1910. Old tailings were worked from along the creek in the Park City region, producing middlings which were re-treated at the dry concentration mill of the Grasselli Chemical Co., which also handled some of the middlings and concentrate produced at other small mills. During the last three months of 1911, 1,136 tons of zinc concentrates, averaging about 35 per cent zinc, accumulated at the Daly Judge mill awaiting a better market. Shipments of zinc concentrate were made regularly from the Daly West mill. Two mines at Bingham were factors in increasing the spelter production of Salt Lake County from 3,572,347 pounds in 1910 to 4,715,121 pounds in 1911. Tooele County mines, of which there were 2 producing zinc in 1911, yielded ore, with recoverable spelter, amounting to 4,452,290 pounds, against a production in 1910 of 2,843,032 pounds. In the Tintic district one property produced zinc ore in 1911 with the prospect of continuing during 1912, along with several other properties in which large bodies of low-grade zinc carbonate ore are known to exist.

*Source of zinc production of Utah, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Zinc ore. | Lead-zinc ore. | Total. |
|---|---|---|---|
| Beaver | ..... | 64,927 | 64,927 |
| Juab | ..... | 11,359 | 11,359 |
| Salt Lake | ..... | 4,715,121 | 4,715,121 |
| Summit | 287,188 | 7,005,586 | 7,292,774 |
| Tooele | 877,876 | 3,574,414 | 4,452,290 |
| Wasatch | ..... | 1,303,790 | 1,303,790 |
| Total | 1,165,064 | 16,675,197 | 17,340,261 |

## METALLURGICAL INDUSTRY.

*List of reduction mills in Utah in 1911, by counties.*

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| BEAVER COUNTY. | | | | *Short tons.* |
| Revenue [a] | Pine Grove | Concentration | Crushers and tables | ..... |
| Beaver Carbonate [b] | San Francisco | do | Jigs and tables | 50 |
| Horn Silver [b] | do | do | Crushers, 30 stamps, jigs, and tables. | 50 |
| Cactus [b] | do | do | Jigs, tables, and vanners. | 1,000 |
| Estella [c] | Star | Amalgamation | 25 stamps | ..... |
| Utah Gold [c] | Washington | Concentration | Crusher and tables | 50 |
| Rob Roy [c] | Newton | Amalgamation | 10 stamps | ..... |
| Sheep Rock [b] | (At Beaver) | Concentration | 5 stamps, and vanners | ..... |

[a] Under construction in 1911. [b] Active in 1911. [c] Idle in 1911.

*List of reduction mills in Utah in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| BOXELDER COUNTY. | | | | |
| | | | | *Short tons.* |
| Susannah [a] | Park Valley | Amalgamation | Crusher, slow speed, Lane mill. | 30 |
| Century [b] | do | Concentration | Crusher, 16 stamps, tables. | 40 |
| Wasatch [b] | Brigham City | do | Crushers and tables | 150 |
| GARFIELD COUNTY. | | | | |
| Smith Fork [b] | White Canyon | Amalgamation | 1 stamp | 3 |
| Bromide [a] | do | Amalgamation, concentration. | 5 stamps | |
| GRAND COUNTY. | | | | |
| Toronado [b] | Miners Basin | Amalgamation | 5 stamps | |
| IRON COUNTY. | | | | |
| Ophir [b] | Stateline | Cyanidation | Crusher and tanks | 100 |
| Big Sunflower [c] | do | Amalgamation, cyanidation. | Crusher, 2 stamps, 3 tanks. | 10 |
| Johnny [b] | do | do | 10 stamps | |
| Jennie [a] | Gold Springs | do | 12' Nissen stamps, plates, and tanks. | |
| JUAB COUNTY. | | | | |
| Sheba [b] | Spring Creek | Amalgamation | 5 stamps, and plates | 15 |
| Godiva [b] | Tintic | Concentration | Crusher, 10 stamps, rolls, jigs, tables, and vanners. | 100 |
| PIUTE COUNTY. | | | | |
| Sevier [a] | Gold Mountain | Amalgamation, cyanidation. | Crushers, 18 stamps, plates, agitators, and tanks. | 90 |
| Annie Laurie [b] | do | Cyanidation | Crusher, rolls, and tanks. | 250 |
| Dalton [b] | Ohio | Concentration | | 15 |
| Bully Boy and Webster [c] | do | Concentration, cyanidation. | Crusher, 10 stamps, Chilean mill, tables, 3 tanks (60 tons). | 100 |
| SALT LAKE COUNTY. | | | | |
| Jefferson [a] | Big Cottonwood | Amalgamation, concentration. | 5 stamps, tables, and vanners. | 12 |
| Columbus Cons. [a] | Little Cottonwood | Concentration | Crushers, rolls, jigs, and tables. | 150 |
| Bingham New Haven [a] | West Mountain | do | Crusher, rolls, 5 tables, and 2 slimers. | 100 |
| Conglomerate [b] | do | do | 10 stamps, rolls, and tables. | 50 |
| Last Chance [b] | do | do | Crushers, jigs, and tables. | 70 |
| New England [a] | do | do | Crusher, rolls, and jigs. | 50 |
| North Utah [a] | do | do | Crushers, rolls, jigs, tables, and vanners. | 180 |
| Ohio Copper [a] | do | do | Crushers, Wall rolls, and tables. | 2,000 |
| Utah Leasing Co. [a] | do | Cyanidation | Crushers, rolls, and tanks. | 30 |
| Phoenix [a] | do | Concentration | Crushers, rolls, sizers, jigs, tables, vanners. | 200 |
| Magna [a] | do | do | Crushers. rolls, 26 Chili mills rolls, 104 classifiers, 182 roughing tables, 26 Wilfley tables, 832 vanners, and 312 dewatering tanks. | 12,000 |
| Arthur [a] | do | do | Crushers, rolls, 39 Chili mills rolls, 72 jigs, 48 Wilfley tables, 1,104 vanners, classifiers, and 384 conical settling tanks. | 8,000 |

[a] Active in 1911. [b] Idle in 1911. [c] Under construction in 1911.

*List of reduction mills in Utah in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| SALT LAKE COUNTY—continued. | | | | *Short tons.* |
| United States Concentrator.[a] | (At Midvale) | Concentration | Crusher, rolls, tube mill, jigs, tables, and dry mill of Huff separators. | 350 |
| Winnamuck[a] | West Mountain | do | Crusher, rolls, jigs, and tables. | 200 |
| SEVIER COUNTY. | | | | |
| Lead Hill[b] | Unorganized | Concentration | 5 stamps and tables | |
| SUMMIT COUNTY. | | | | |
| Hansen[a] | Uintah | Concentration of tailings. | Jigs, tables, and classifier. | |
| Moore[a] | do | do | Jigs and tables | |
| Anderson[a] | do | do | do | |
| Silver King[a] | do | Concentration | Crushers, rolls, jigs, tables, and slimers. | 300 |
| Grasselli (dry)[a] | do | Dry concentration | Sutton tables and electrostatic separators. | 100 |
| Grasselli (wet)[a] | do | Wet concentration | Rolls, classifiers, tables | 125 |
| California and Comstock.[a] | do | Concentration | Crusher, rolls, tables, and jigs. | 60 |
| Daly West[a] | do | do | Crusher, rolls, jigs, and tables. | 400 |
| Duffy[b] | do | Concentration of tailings. | Jigs and tables | 50 |
| Ontario[c] | do | Chlorination | Crushers, rolls, roaster, and leaching tanks. | 100 |
| Clegg[b] | do | Concentration of tailings. | Jigs and tables | |
| Little Bell[b] | do | Concentration | Crushers, rolls, and tables. | |
| Beggs[a] | do | Concentration of tailings. | Jig and table | |
| Miller & Beggs[a] | do | do | Classifiers and Macquisten tables. | |
| TOOELE COUNTY. | | | | |
| Consolidated Mercur[a] | Camp Floyd | Cyanidation | Crushers, rolls, roasters, tanks, Dorr classifiers, and thickeners. | 1,000 |
| Daisy Combination[a] | do | do | Crushers, rolls, and tanks. | 100 |
| Sacramento[b] | do | do | do | 140 |
| Mono[a] | Ophir | Concentration | 2 hand jigs | 2 |
| Chloride Point[b] | do | Cyanidation | Crushers, rolls, and tanks. | 75 |
| Ophir Hill[b] | do | Concentration | Crusher, rolls, 12 Wilfley tables, and 10 Hartz jigs. | 150 |
| New Stockton[b] | Rush Valley | do | Crusher, rolls, 4 Wilfley tables, and 3 Woodbury tables. | 150 |
| Midas[b] | Clifton | Cyanidation | Crusher and 5 tanks | 40 |
| UTAH COUNTY. | | | | |
| May Day (at Eureka)[a] | Tintic | Dry concentration | Crusher, rolls, jigs, and Wilfley tables. | 50 |
| WASATCH COUNTY. | | | | |
| Adirondack[b] | Blue Ledge | Concentration | | 150 |
| Daly Judge[a] | Snake Creek | do | Crusher, rolls, 2 Huntington mills, 22 Wilfley tables, 8 Hartz jigs. | 450 |
| WASHINGTON COUNTY. | | | | |
| Free Coinage[b] | Harrisburg | Amalgamation | 5 stamps | 15 |

[a] Active in 1911. [b] Idle in 1911. [c] Remodeling.

Very little change was noted in the milling plants, except a change in the operating policy at the United States concentrator at Midvale to accept custom ores for concentration, especially the low-grade iron-lead-zinc sulphide ores. Wet concentration at the Midvale mill yields a lead and lead-iron-zinc middling product. The latter is fed dry to Huff electrostatic separators, which make a lead-iron concentrate and about 45 tons of zinc concentrate daily. The lead-iron concentrate is smelted at the Midvale smelter and the zinc is shipped to a refinery at Carney, Kansas. At Garfield the Utah Copper Co.'s two mills treated 4,680,801 tons of ore, as compared with 4,340,245 tons in 1910. The larger of the two concentrating plants, known as the Magna, has a capacity of 12,000 tons of ore a day, having operated at that rate since August. The smaller mill, called the Arthur, was planned for 13 sections. Five sections were built and have been in operation since September 1, 1911, treating 3,000 tons a day, and the sixth section has since been completed and put in operation. When the Arthur plant shall have been completed as to the 13 sections contemplated, facilities for the concentration of 20,000 tons of ore a day will have been accomplished. The Bingham-New Haven concentration mill at Bingham and the cyanide mill of the lessees working on the silver ores of the Telegraph mine were in regular operation. Near Park City, the Daly-Judge, Daly West, and Grasselli concentrators made zinc, as well as lead concentrate. An auxiliary plant for wet concentration was built by the Grasselli Co. to treat tailings from along Silver Creek, but was not operated continuously. Adjacent to the dry-concentration mill of the company, a plant is under construction for re-treating the discarded tailings for zinc and lead. Wilfley tables and the Macquisten tube flotation process will be used. The capacity will be about 40 tons of tailings daily. There are 7 mills in Utah equipped for amalgamation of gold ores, but only 1 was in operation in 1911. Concentration mills number 40, of which 27 were operated. There are 8 cyanide plants, of which only 3 were working. Amalgamation and concentration were used at 3 mills, of which 2 were active. Amalgamation followed by cyanide treatment is in use at 5 plants, of which 2 were operating. At 1 plant, which was in operation in 1911, amalgamation, concentration, and cyanidation are used. The chlorination process is to be used in one of the old mills which is being remodeled. Mercur, in Tooele County, continues to be the only large producer of gold by the cyanide process. In all, there were 267,111 tons of ore and 4,600 tons of tailings treated at gold and silver mills using amalgamation and cyanidation in 1911. The total average recovery by amalgamation was $3.23 in gold and 0.20 ounce of silver per ton and at cyanide mills the total average recovery was $2.29 in gold and 0.42 ounce of silver per ton. An effort was made to learn the quantity of quicksilver, potassium cyanide, and sodium cyanide consumed, and from reports received 105 pounds of quicksilver were used and 205,041 pounds of potassium cyanide. No sodium cyanide was reported. The average consumption of quicksilver per ounce of gold and silver bullion recovered was 0.058 pound and of potassium cyanide 1.45 pounds.

*Output of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Utah in 1911, by counties.*

| County. | Quantity. | Bullion recovered from ore by— | | | | Total value. |
|---|---|---|---|---|---|---|
| | | Amalgamation. | | Cyanidation. | | |
| | | Gold. | Silver. | Gold. | Silver. | |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Fine ounces.* | *Fine ounces.* | |
| Beaver | 20 | 43.37 | 153 | | | $978 |
| Boxelder | 800 | [a] 294.39 | [a] 59 | | | 6,116 |
| Garfield | 100 | 39.81 | 11 | | | 829 |
| Iron | 198 | | | 80.79 | 766 | 2,076 |
| Piute | 3,000 | 394.57 | 802 | 602.25 | 200 | 21,137 |
| Salt Lake | [b] 10,300 | 13.08 | 4 | 1,272.00 | 109,975 | 84,853 |
| Summit | 5 | | | .30 | 218 | 122 |
| Tooele | 252,688 | | | [c] 27,571.67 | [c] 305 | 570,119 |
| Total | 267,111 | 785.22 | 1,029 | 29,527.01 | 111,464 | 686,230 |

[a] Includes bullion from 1,000 tons of old tailings.
[b] Also yielded 8 tons of concentrates, included with metal content in table of concentrates produced.
[c] Includes bullion from 3,600 tons of old tailings.

At plants equipped for concentration, 5,840,091 tons of ore were crushed and milled, yielding 357,370 tons of concentrate. The tonnage of copper concentrate was the largest, aggregating 228,591 tons, which, aside from 8 tons from gold and silver mills, averaged $3.85 in gold, 1.89 ounces of silver, 463.50 pounds of copper, and a total value of $62.79 per ton. The lead concentrate aggregated 107,006 tons, averaging $1.46 in gold, 17.90 ounces of silver, 13 pounds of copper, 427 pounds of lead, and $31.80 in value per ton. Copper-lead concentrates aggregated 291 tons in quantity and averaged 27 cents in gold, 31 ounces of silver, 100.8 pounds of copper, 157.63 pounds of lead, and $36.40 in value per ton. Zinc concentrates aggregating 21,482 tons were saved from 49,749 tons of old tailings and 227,472 tons of ore. The average recovery assay of the zinc concentrates was 6 cents in gold and 5.69 ounces of silver per ton, and 0.03 per cent of copper, 2.56 per cent of lead, and 30.62 per cent of zinc (spelter), and $40.38 in value per ton. The bulk of the zinc concentrate contained an average of 45 per cent of zinc, but some of the zinc middlings of lower grade were mixed with the shipments.

*Mine production of gold, silver, copper, lead, and zinc from Utah concentrates in 1911, by counties.*

| County. | Ore to concentrating mills. | Concentrates produced. | | | | | | Total value of concentrates. |
|---|---|---|---|---|---|---|---|---|
| | | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Beaver | 247,069 | 21,416 | 1,566.38 | 36,189 | 3,440,014 | 164,014 | | $488,943 |
| Salt Lake | 5,370,639 | 272,231 | 46,155.92 | 769,178 | 103,204,434 | 16,708,613 | 4,560,118 | 15,274,160 |
| Summit | 152,132 | 48,129 | 1,974.66 | 1,365,565 | 591,651 | 23,380,299 | 7,292,774 | 2,306,327 |
| Utah | 18,376 | 574 | 68.12 | 9,142 | | 289,291 | | 19,271 |
| Wasatch | 51,875 | 15,020 | 460.04 | 297,938 | 154,226 | 6,305,624 | 1,303,790 | 544,764 |
| Total | 5,840,091 | 357,370 | 50,225.12 | 2,478,012 | 107,390,325 | 46,847,841 | 13,156,682 | 18,633,465 |
| Subdivision by kinds of concentrates: | | | | | | | | |
| Copper | | 228,591 | 42,589.23 | 431,405 | 105,951,588 | | | 14,352,989 |
| Lead | | 107,006 | 7,568.01 | 1,915,322 | 1,394,266 | 45,702,551 | | 3,402,464 |
| Zinc | | 21,482 | 64.12 | 122,264 | 15,117 | 1,099,418 | 13,156,682 | 867,420 |
| Copper-lead | | 291 | 3.76 | 9,021 | 29,354 | 45,872 | | 10,592 |

*Kinds of concentrates and average metallic content of milling ore and concentrates produced in Utah in 1911.*

| Kinds of concentrates and source of production. | Milling ore. | Concentrate. | Average metallic content per ton. | | | | | | | | | | Average value per ton. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gold. | | Silver. | | Copper. | | Lead. | | Zinc. | | | |
| | | | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. | Crude ore. | Concentrate. |
| Copper: | *Short tons.* | *Short tons.* | | | *Fine ounces.* | *Fine ounces.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | | |
| Gold and silver mills | 100 | 8 | $0.85 | $10.62 | 0.15 | 1.88 | 0.63 | 7.90 | ..... | ..... | ..... | ..... | $2.50 | $31.25 |
| Concentration mills | 5,476,916 | 228,583 | .16 | 3.85 | .08 | 1.89 | .97 | 23.18 | ..... | ..... | ..... | ..... | 2.62 | 62.79 |
| Lead: | | | | | | | | | | | | | | |
| Concentration mills | 361,924 | 107,006 | .43 | 1.46 | 5.29 | 17.90 | .19 | .65 | 6.31 | 21.35 | ..... | ..... | 9.40 | 31.80 |
| Zinc: | | | | | | | | | | | | | | |
| Concentration mills | [a] 277,221 | 21,482 | ..... | .06 | .44 | 5.69 | ..... | .03 | .20 | 2.56 | 2.37 | 30.62 | 3.13 | 40.38 |
| Copper-lead: | | | | | | | | | | | | | | |
| Concentration mills | 1,251 | 291 | .06 | .27 | 7.21 | 31.00 | 1.17 | 5.04 | 1.83 | 7.88 | ..... | ..... | 8.47 | 36.40 |

[a] Includes 49,749 tons of old tailings.

Smelting operations throughout 1911 were without any especial feature, serious accidents, or labor difficulty, and enjoyed freedom from interference on the part of the ranchers, who in previous years have practically closed all of the plants within the State by claiming damage to their crops. Four smelters in and near Salt Lake City maintained operations at almost normal capacity. These were the American Smelting & Refining Co.'s copper smelter at Garfield and its lead plant at Murray; the United States Smelting, Refining & Mining Co's lead smelter at Midvale; and the International Smelting & Refining Co.'s copper smelter at Tooele. The largest of these plants is the Garfield works, where the concentrate production of the Utah Copper Co. is reduced to matte and where the crude copper ores of smelting grade of the Yampa, at Bingham, and of other mines of the State are treated. The capacity of the plant is about 3,000 tons of charge, with a possible daily capacity of 3,500 tons, but the average was probably about 2,500 tons during 1911. The plant has 6 reverberatory and 4 blast furnaces. At Murray the lead plant belonging to the same interests probably treated an average of 1,000 tons of charge daily during 1911, with an average of 4 to 5 furnaces in operation. The Midvale plant of the United States Co. averaged about 1,000 tons of charge daily in 1911, having from 5 to 6 furnaces in continual operation, the furnaces being slightly smaller than the Murray furnaces of the American Co.

The International Co., at Tooele, began operations in 1910, and it has gradually increased the capacity of its 3 reverberatories in operation until the average for the whole year of 1911 approximated 500 tons daily. In December last these reverberatories were handling about their capacity, each close to 230 tons daily. The company has 2 additional furnaces in reserve, and all 5 will be in operation during 1912.

One of the most important features of the year in the Utah smelting field was the determination of the International Co. to enter the lead-smelting business, and ground was broken during 1911 for such a plant beside the copper smelter at Tooele. This plant will have three furnaces with available building space for others as needed. The ore-purchasing department of the company has been very successful in securing some of the largest lead producers in Utah, Idaho, and Nevada as customers. Ores have been received for many months past and there are piled at Tooele from 25,000 to 30,000 tons of lead ores in readiness for the blowing in of the new plant.

The bulk of the crude ore from Utah mines was shipped directly to smelting plants situated near Salt Lake City. Some ore was treated at smelters in Colorado; the zinc-bearing ore went to Kansas and Oklahoma, and some zinc-lead ore to Wisconsin. The quantity of crude ore smelted in 1911 exceeded the tonnage of concentrate and aggregated 1,103,054 tons, valued at $17,364,933, or an average of $15.74 per ton. The dry or siliceous ores directly smelted averaged $5.30 in gold, 12.94 ounces of silver, 17.19 pounds of copper, 13.4 pounds of lead, and $14.91 in value per ton; copper ores, $2.36 in gold, 3.01 ounces of silver, 51 pounds of copper, and $10.34 in value per ton; lead ores, $1.82 in gold, 20.66 ounces of silver, 10 pounds of copper, 322.4 pounds of lead, and $28.51 in value per ton; zinc ores yielded 33.35 per cent of zinc (figured as spelter) per ton,

but the gold, silver, copper, or lead contents were not saved. Copper lead ore shipped to smelters averaged 98 cents in gold, 32.83 ounces of silver, 125.6 pounds of copper, 328 pounds of lead, and $48.85 in value per ton; lead-zinc ores contained 17 cents in gold, 1.03 ounces of silver, 0.4 pound of copper, 215.2 pounds of lead, 473.80 pounds of spelter, and $37.46 in value per ton. The content of each kind of crude ore shipped to smelters is given by counties in the following table:

*Mine production of gold, silver, copper, lead, and zinc from Utah crude ore shipped to smelters in 1911, by counties.*

| County. | Crude ore to smelter. | | | | | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Beaver | 12,291 | 680.55 | 163,691 | 296,787 | 4,344,059 | 64,927 | $337,106 |
| Boxelder | 1,717 | 6.02 | 2,232 | 289,769 | 70,385 | ..... | 40,695 |
| Grand | 6 | .10 | 360 | 342 | 236 | ..... | 247 |
| Iron | 4 | 6.00 | 240 | 3 | ..... | ..... | 255 |
| Juab | 301,326 | 72,579.87 | 4,673,698 | 10,927,100 | 15,015,484 | 11,359 | 6,019,651 |
| Millard | 77 | 58.73 | 905 | 1,411 | 15,155 | ..... | 2,552 |
| Morgan | 26 | .29 | 149 | ..... | 16,890 | ..... | 845 |
| Piute | 158 | 259.38 | 4,391 | 7,816 | ..... | ..... | 8,666 |
| Salt Lake | 666,546 | 61,585.15 | 2,046,057 | 26,405,388 | 30,913,527 | 155,003 | 7,058,106 |
| Sevier | 1,291 | 6.43 | 1,291 | ..... | ..... | ..... | 817 |
| Summit | 34,981 | 1,921.07 | 1,517,042 | 369,471 | 14,356,609 | ..... | 1,535,976 |
| Tooele | 34,790 | 723.43 | 276,089 | 293,106 | 11,741,293 | 4,452,290 | 980,059 |
| Utah | 42,233 | 6,473.73 | 925,626 | 7,836 | 9,522,802 | ..... | 1,053,911 |
| Wasatch | 7,608 | 588.05 | 247,888 | 165,842 | 3,595,110 | ..... | 326,047 |
| Total | 1,103,054 | 144,888.80 | 9,859,665 | 38,764,871 | 89,591,550 | 4,683,579 | 17,364,933 |
| Subdivision by kinds of ore: | | | | | | | |
| Dry or siliceous | 189,424 | 48,567.32 | 2,451,673 | 3,256,340 | 2,552,128 | ..... | 2,825,253 |
| Copper | 640,729 | 73,160.10 | 1,926,406 | 32,637,950 | 338,688 | ..... | 6,628,332 |
| Lead | 261,333 | 22,989.65 | 5,400,455 | 2,587,717 | 84,244,320 | ..... | 7,451,938 |
| Zinc | 1,316 | ..... | ..... | ..... | ..... | 877,876 | 50,039 |
| Copper-lead | 2,219 | 105.68 | 72,849 | 278,772 | 728,046 | ..... | 108,404 |
| Lead-zinc | 8,033 | 66.05 | 8,282 | 4,092 | 1,728,368 | 3,805,703 | 300,967 |

*Crude ore, by kinds, and average metallic content of each kind shipped to smelters in Utah in 1911.*

| Kind of crude ore. | Quantity. | Average metallic content per ton. | | | | | Average value per ton. |
|---|---|---|---|---|---|---|---|
| | | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | | *Fine ounces.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Dry or siliceous | 189,424 | $5.30 | 12.94 | 0.86 | 0.67 | ..... | $14.91 |
| Copper | 640,729 | 2.36 | 3.01 | 2.55 | .03 | ..... | 10.34 |
| Lead | 261,333 | 1.82 | 20.66 | .50 | 16.12 | ..... | 28.51 |
| Zinc | 1,316 | ..... | ..... | ..... | ..... | 33.35 | 38.02 |
| Copper-lead | 2,219 | .98 | 32.83 | 6.28 | 16.41 | ..... | 48.85 |
| Lead-zinc | 8,033 | .17 | 1.03 | .02 | 10.76 | 23.69 | 37.46 |

## MINING INDUSTRY IN UTAH IN 1911.

Producers during 1911 labored under difficulties attending weak metal markets, as well as by reason of an increased cost of production on account of the increasing depth, generally, at which the ores were mined. Nevertheless the mining companies in Utah disbursed

dividends aggregating $8,968,350 in 1911, against $8,753,373 paid to stockholders in 1910. In 1911 the restricted production of the numerous mining camps was caused by some of the greatest producing mines closing down completely for a short time to re-equip the properties with more modern machinery or to carry on extensive developments. Notwithstanding this, an increase was made in output of all the metals reported by mine producers. This total mine production reported exceeds the smelter production, for the reason that there was a great deal more lead, silver, and gold ore mined and sold to the smelters of Utah in 1911 than was smelted. The policy of the United States Co. to buy custom ores for its concentrator has permitted ore to be mined that had been regarded as practically without value. Several large contracts were made by mining companies with the smelters for the sale of siliceous gold and silver ores, which have been the means of cleaning up one or two mine dumps of waste and old tailings. Shippers of all grades and kinds of ore find an impartial market in Utah through the medium of custom sampling works controlled by the Utah Ore Sampling Co., which has works at Murray, Park City, and Silver City. The ore is crushed and sampled at these works for the mine owner, and the odd lots of ore are sold to the highest bidder in the open market.

Railroad facilities were increased in 1911 by the Bingham & Garfield Railway going into operation between the Utah Copper mine and its mills at Garfield; it carried as much as 14,500 tons of ore in one day. The Denver & Rio Grande Railroad between the two points handled 7,500 tons a day. Two roads were projected for eastern and southern Utah, and the Western Pacific operated regular freight and passenger service, serving Wendover, which is the station for the Silver Islet mining district, the Ophir district, the Stockton district, and the Tooele smelter.

*Mine production of gold, silver, copper, lead, and zinc in Utah in 1911, by counties.*

| County. | Gold. | | | | Silver. | |
|---|---|---|---|---|---|---|
| | Placers. | | Deep mines. | | | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | *Fine ozs.* | | *Fine ozs.* | | *Fine ozs.* | |
| Beaver | | | 2,301.10 | $47,568 | 201,259 | $106,667 |
| Boxelder | | | 300.41 | 6,210 | 2,291 | 1,214 |
| Garfield | 52.20 | $1.079 | 39.81 | 823 | 20 | 11 |
| Grand | | | .10 | 2 | 360 | 191 |
| Iron | | | 86.79 | 1,794 | 1,012 | 537 |
| Juab | | | 72,579.87 | 1,500,359 | 4,673,698 | 2,477,060 |
| Millard | | | 58.73 | 1,214 | 905 | 480 |
| Morgan | | | .29 | 6 | 149 | 79 |
| Piute | | | 1,256.20 | 25,968 | 5,393 | 2,858 |
| Salt Lake | | | 110,533.68 | 2,284,934 | 2,947,481 | 1,562,165 |
| San Juan | 52.00 | 1.075 | | | 12 | 6 |
| Sevier | | | 6.43 | 133 | 1,291 | 684 |
| Summit | | | 3,896.03 | 80,538 | 2,882,825 | 1,527,897 |
| Tooele | | | 28,295.36 | 584,917 | 276,485 | 146,537 |
| Uinta | 168.34 | 3,480 | | | 12 | 6 |
| Utah | | | 6,541.85 | 135,232 | 934,768 | 495,427 |
| Wasatch | | | 1,048.09 | 21,666 | 545,826 | 289,288 |
| Total | 272.54 | 5,634 | 226,944.74 | 4,691,364 | 12,473,787 | 6,611,107 |

*Mine production of gold, silver, copper, lead, and zinc in Utah in 1911, by counties.* Continued.

| County. | Copper. | | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | *Pounds.* | | |
| Beaver | 3,739,282 | $467,410 | 4,534,678 | $204,060 | 64,927 | $3,701 | $829,46 |
| Boxelder | 289,769 | 36,221 | 70,385 | 3,167 | ..... | ..... | 46,81 |
| Garfield | ..... | ..... | ..... | ..... | ..... | ..... | 1,91 |
| Grand | 342 | 43 | 236 | 11 | ..... | ..... | 2 |
| Iron | 3 | 1 | ..... | ..... | ..... | ..... | 2,3 |
| Juab | 10,927,100 | 1,365,888 | 15,015,484 | 675,697 | 11,359 | 647 | 6,019,6 |
| Millard | 1,411 | 176 | 15,155 | 682 | ..... | ..... | 2,5 |
| Morgan | ..... | ..... | 16,890 | 760 | ..... | ..... | 8 |
| Piute | 7,816 | 977 | ..... | ..... | ..... | ..... | 29,8 |
| Salt Lake | 130,412,972 | 16,301,621 | 47,647,390 | 2,144,133 | 4,715,121 | 268,762 | 22,561,61 |
| San Juan | ..... | ..... | ..... | ..... | ..... | ..... | 1,0 |
| Sevier | ..... | ..... | ..... | ..... | ..... | ..... | 8 |
| Summit | 961,122 | 120,140 | 37,736,908 | 1,698,161 | 7,292,774 | 415,688 | 3,842,42 |
| Tooele | 293,106 | 36,638 | 11,746,797 | 528,606 | 4,452,290 | 253,781 | 1,550,47 |
| Uinta | ..... | ..... | ..... | ..... | ..... | ..... | 3,48 |
| Utah | 7,836 | 979 | 9,812,093 | 441,544 | ..... | ..... | 1,073,18 |
| Wasatch | 320,068 | 40,009 | 9,900,734 | 445,533 | 1,303,790 | 74,316 | 870,81 |
| Total | 146,960,827 | 18,370,103 | 136,496,750 | 6,142,354 | 17,840,261 | 1,016,895 | 36,837,45 |

*Output of ore sold or treated, number of deep mines producing, and values of ores in Utah in 1910 and 1911, by counties.*

| County. | Ore sold or treated. | | Number of deep mines producing. | | Average value per ton.[a] | | Average value per ton in gold and silver.[a] | |
|---|---|---|---|---|---|---|---|---|
| | 1911 | Increase (+) or decrease (−). | 1910 | 1911 | 1910 | 1911 | 1910 | 1911 |
| | *Short tons.* | *Short tons.* | | | | | | |
| Beaver | 259,695 | +175,947 | 21 | 29 | $7.71 | $3.19 | $2.39 | $0.59 |
| Boxelder | 3,517 | − 20,624 | 3 | 8 | 6.81 | 13.31 | .79 | 2.11 |
| Garfield | 100 | + 100 | ..... | 1 | ..... | 8.29 | ..... | 8.29 |
| Grand | 6 | + 6 | ..... | 1 | ..... | 41.17 | ..... | 32.17 |
| Iron | 202 | − 277 | 2 | 3 | 11.02 | 11.54 | 11.02 | 11.54 |
| Juab | 301,326 | + 58,349 | 38 | 39 | 21.66 | 19.98 | 13.38 | 13.20 |
| Millard | 77 | + 77 | ..... | 3 | ..... | 33.14 | ..... | 22.00 |
| Morgan | 26 | − 125 | 1 | 1 | 13.64 | 32.50 | 3.17 | 3.27 |
| Piute | 3,158 | − 3,089 | 6 | 5 | 4.63 | 9.44 | 4.38 | 9.13 |
| Salt Lake | 6,051,042 | +608,784 | 52 | 49 | 3.49 | 3.73 | .52 | .63 |
| Sevier | 1,291 | + 1,291 | ..... | 1 | ..... | .63 | ..... | .63 |
| Summit | 236,867 | + 77,636 | 16 | 22 | 17.42 | 16.22 | 7.62 | 6.79 |
| Tooele | 291,131 | − 23,351 | 22 | 21 | 4.44 | 5.33 | 2.62 | 2.51 |
| Utah | 60,609 | + 1,033 | 13 | 15 | 31.22 | 17.70 | 16.97 | 10.40 |
| Wasatch | 59,483 | + 3,375 | 1 | 2 | 19.17 | 14.64 | 6.56 | 5.23 |
| Total | 7,268,530 | +879,132 | 175 | 200 | 5.04 | 5.07 | 1.52 | 1.55 |

[a] Value per ton, placer product excluded.

*Number of mines classified by chief products in Utah, in 1911, by counties.*

| County. | Mines reporting product. | Gold placer mines. | Deep mines. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gold and silver. | Gold, silver, and copper. | Gold, silver, copper, and lead. | Gold, silver, copper, lead, and zinc. | Gold, silver, and lead. | Silver and copper. | Silver and lead. | Silver, lead, and zinc. |
| Beaver | 29 | ..... | 1 | 4 | 20 | 1 | 2 | ..... | 1 | ..... |
| Boxelder | 8 | ..... | 2 | 1 | 3 | ..... | ..... | 1 | [a] 1 | ..... |
| Garfield | 6 | 5 | 1 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Grand | 1 | ..... | 1 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Iron | 3 | ..... | 2 | 1 | ..... | ..... | ..... | ..... | ..... | ..... |
| Juab | 39 | ..... | 2 | 6 | 25 | ..... | 5 | ..... | ..... | [b] 1 |
| Millard | 3 | ..... | 1 | 1 | 1 | ..... | ..... | ..... | ..... | ..... |
| Morgan | 1 | ..... | ..... | ..... | ..... | ..... | 1 | ..... | ..... | ..... |
| Piute | 5 | ..... | 4 | 1 | ..... | ..... | ..... | ..... | ..... | ..... |
| Salt Lake | 49 | ..... | ..... | 6 | 34 | 3 | 5 | ..... | [a] 1 | ..... |
| San Juan | 2 | 2 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Sevier | 1 | ..... | 1 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Summit | 22 | ..... | ..... | ..... | 10 | [c] 10 | 1 | ..... | ..... | [b] 1 |
| Tooele | 21 | ..... | [d] 3 | ..... | 9 | 2 | 5 | ..... | [a] 2 | ..... |
| Uinta | 1 | 1 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Utah | 15 | ..... | 1 | ..... | 3 | ..... | 9 | ..... | 2 | ..... |
| Wasatch | 2 | ..... | ..... | ..... | ..... | 1 | ..... | ..... | ..... | ..... |
| Total | 208 | 8 | 19 | 20 | 106 | 17 | 28 | 1 | 7 | 2 |

[a] Contains also copper.
[b] Contains also gold.
[c] Three contain zinc only.
[d] One contains gold only.

## REVIEW BY COUNTIES.

### BEAVER COUNTY.

*Mine production of gold, silver, copper, lead, and zinc in Beaver County, Utah, in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold, fine ounces | 827.89 | $17,114 | 2,301.10 | $47,568 | + 1,473.21 | +$30,454 |
| Silver, do | 339,881 | 183,536 | 201,259 | 106,667 | − 138,622 | − 76,869 |
| Copper, pounds | 1,128,785 | 143,356 | 3,739,282 | 467,410 | +2,610,497 | +324,054 |
| Lead, do | 6,235,535 | 274,363 | 4,534,678 | 204,060 | −1,700,857 | − 70,303 |
| Zinc, do | 513,733 | 27,742 | 64,927 | 3,701 | − 448,806 | − 24,041 |
| Total | ..... | 646,111 | ..... | 829,406 | ..... | +183,295 |

Ores were produced from 29 properties aggregating 259,695 tons in 1911. This is 175,947 tons more ore and 8 more properties than were reported in 1911. The quantity of ore increased, but the average value decreased from $7.71 in 1910 to $3.19 per ton in 1911, and the gold and silver value from $2.39 to $0.59 per ton. The copper ores are low in gold and silver content, and this is the reason for the marked decrease in those metals, as the output of low-grade copper ores increased from 65,534 tons in 1910 to 245,817 tons in 1911. The lead ores, which carry considerable average values in silver, decreased from 13,019 tons to 11,533 tons. The greater part of the mine output, or 247,069 tons of ore, was concentrated, producing 21,416 tons of copper and lead concentrate, which contained $32,380 in gold, 36,189

ounces of silver, 3,440,014 pounds of copper, and 164,014 pounds of lead, valued in all at $488,943, or an average of $22.83 per ton. Copper, lead, and zinc ores were shipped directly to the smelters. A large percentage of lead ore was carbonate and the copper and zinc ores were sulphides. The total content of 12,291 tons of shipping ore was $14,068 in gold, 163,691 ounces of silver, 296,787 pounds of copper, 4,344,059 pounds of lead, and 64,927 pounds of zinc, valued in all at $337,106, or an average of $27.43 per ton. A small tonnage of free gold siliceous ore was milled from one property in the county and shipments of slag from the old dumps at Frisco were made to the smelters, yielding gold, silver, copper, and lead.

*Bradshaw district.*—Small shipments of oxidized iron ore, containing a small quantity of lead, silver, and gold, were made from the Lower Cave mine.

*Newton district.*—The Sheep Rock and Rob Roy properties were operated a short time in 1911, each of them producing gold and silver ore, from which some bullion was produced, and the remainder of the ore was shipped to smelters. The Sheep Rock property is opened by a shaft 300 feet deep, and all the work performed in 1911 was by lessees, who hauled the ore and treated it in a small mill at Beaver.

*Pine Grove district.*—Silver ore, containing gold and a little copper, was shipped from the property of the Park Mining Co., opened by a shaft 150 feet deep. The ores produced are sulphides, and it is reported that the oxidized ores extend to a depth of 75 feet below the surface.

*Preuss district.*—Ores containing lead, silver, some gold, and a little copper were shipped from the Indian Queen property.

*San Francisco district.*—Nine producers reported the production of 254,444 tons of ore, containing $38,253 in gold, 134,225 ounces of silver, 3,639,116 pounds of copper, 2,413,042 pounds of lead, and 64,927 pounds of zinc, valued in all at $676,569. The larger part of the output was the low-grade monzonite-porphyry ore of the Cactus mine. The output of concentrates was recovered from 247,069 tons of ore. Ore of shipping grade aggregated 7,084 tons, containing 277.49 ounces of gold, 96,856 ounces of silver, 196,930 pounds of copper, 2,223,231 pounds of lead, and 64,927 pounds of zinc. Besides these shipments, there were 291 tons of slag, assorted from the old smelter dumps, containing lead, silver, some copper, and gold. The dump of the Carbonate and Rattler property was worked by lessees and some ore and concentrates were shipped. Operators of the Horn Silver made some additions to the concentration mill and produced a small output of lead concentrate. It was found that it was more profitable to ship the ores to the smelters at Salt Lake. The bulk of the shipping ore consisted of lead ore, copper ore, and zinc ore. A few shipments of copper ore carrying silver and gold were made from the Imperial mine. The Cactus mine, where the largest mining operations were carried on, is opened by a shaft 600 feet deep, and from that level the incline shaft starts and is 300 feet deep. The adit through which the ore is transported is 5,600 feet long. Development in 1911 consisted mainly in drifting on the 700-foot level, and within the year the capacity of the concentrating mill was increased from 800 to 1,000 tons per day. The crude ore and concentrate are sulphides, the ores containing much iron, for which the smelting company pays a bonus.

*Star district.*—All the ore mined by 14 producers was shipped directly to smelters and aggregated 4,734 tons, containing $1,422 in

gold, 51,809 ounces of silver, 86,299 pounds of copper, and 2,051,357 pounds of lead, valued in all at $131,979, or an average of $27.88 per ton. The largest shipments of lead ore were made from the Moscow, Hub and Lady Bryan, Red Warrior, and Harrington-Hickory properties.

BOXELDER COUNTY.

A large decrease in the mine output, which was 20,624 tons and $117,683 in value in 1911, was caused by the lessened operations of the Copper Mountain property, which, with other properties in the county, supplied only 3,517 tons of ore. There were 8 producing properties in 1911, against 3 in 1910, and the total value of the ore increased from $6.81 to $13.31 per ton and the gold and silver value from $0.79 to $2.11 per ton. Ore of shipping grade aggregated 1,717 tons, of which 1,518 tons were copper ore and 161 tons were selected lead ore. The smelting ore averaged $23.70 in value per ton. Siliceous gold ores and some old tailings yielded gold and silver bullion by amalgamation.

*Lucin district.*—Reports from 5 producers gave an aggregate yield of 1,715 tons of ore shipped directly to the smelters, containing $124 in gold, 2,122 ounces of silver, 289,659 pounds of copper, and 70,385 pounds of lead, valued in all at $40,623, or an average of $23.69 per ton. The largest shipments were made from the Copper Mountain property, and consisted of copper ore mined by lessees. The Tecoma mine produced some lead ore containing considerable values in silver and gold and a little copper. The Clipper claim also yielded some ore similar in character.

*Park Valley district.*—The Susannah property was the main producer of ore, which was treated in a 30-ton Lane slow-speed Chilean mill and yielded gold and silver bullion. The property is opened by an adit 300 feet long. At the Century mine the old tailing dump was worked over by the company.

GARFIELD COUNTY.

One producer reported the treatment of 100 tons of gold and silver ore by amalgamation in 1911. Placer operators on Colorado River and in the White Canyon district reported the production of $1,084 from gold and silver bullion.

*Colorado River district.*—Some ore was treated from the Bromide property, the mill of which is equipped for amalgation and concentration. The gold and silver bullion was shipped and the concentrates were held, which assayed about 2 ounces of gold and 15 ounces of silver per ton and 20 per cent of copper. The property is opened by an adit 380 feet long.

*White Canyon district.*—Three reports from placer operators gave an aggregate yield of $630 in gold and 5 ounces of silver, taken from properties near Hite.

GRAND COUNTY.

One producer reported the shipment of 6 tons of copper-lead ore, containing silver and small values in gold. The total average value was $41.17 per ton.

*La Sal district.*—The only shipments made were by the lessees of the High Ore group, and consisted of sulphide ore with good silver values and a small quantity of copper and lead, with a trace of gold.

### IRON COUNTY.

The tonnage of ore reported by 3 producers in 1911 aggregated 202 tons. The average content, which consisted of gold and silver, was valued at $11.54 per ton. Some bullion was cleaned up from one of the mills in the district, making the value of the total output of gold and silver only $2,332. The principal production came from a clean-up of the Jennie mill, in the Gold Springs district.

### JUAB COUNTY.

The total ore output of Juab County aggregated 301,326 tons in 1911, yielded by 39 producers. This is 58,349 tons more ore, and 1 more producer, than was reported in 1910. The average value per ton corresponded inversely to the tonnage and decreased from $21.66 in 1910 to $19.98 in 1911, and the gold and silver value decreased from $13.38 to $13.20 per ton. All of the ores mined were of smelting grade and were valued at $6,019,651. The bulk of the ore, or 179,372 tons, was dry or siliceous, and contained about two-thirds of the gold, half of the silver, and one-third of the copper. The principal part of the tonnage was mined from 31 properties in the Tintic district, to which was credited 300,313 tons of ore, having a total value for the gold, silver, copper, and lead contained, of $5,935,152. There was very little change in the total value of the output of 1911 over that of 1910, the increase being due chiefly to a larger output of gold siliceous ores, which increased the total value from $5,176,480 to $5,935,152. As the larger part of the Tintic district lies in Juab County and the smaller part is in Utah County, the review is given under this section.

*Detroit district.*—The Ibex property produced one shipment of copper ore, carrying considerable values in gold and a little silver. Shipments of siliceous ore, carrying gold, silver, and copper were made from the Copper Head property.

*Fish Springs district.*—The Utah mine continues to be the largest producer of lead-silver ores, carrying a little gold and a trace of copper. The property is opened by a vertical shaft 800 feet deep. The Vulcan, Carnation, and Emma properties were productive of similar ore.

*Mount Nebo district.*—The Eva mine yielded a lead ore and some zinc carbonate ore, of which it is said several large bodies are developed. The property is opened by an adit 500 feet long.

*Tintic district.*—The following table shows the production of Tintic district in 1910 and 1911:

*Mine production of gold, silver, copper, and lead in the Tintic district, Juab and Utah counties, Utah, in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 66,289.22 | $1,370,320 | 79,015.54 | $1,633,396 | + 12,726.32 | +$263,076 |
| Silver.....do.... | 5,222,742 | 2,820,281 | 5,514,702 | 2,922,792 | + 291,960 | + 102,511 |
| Copper.....pounds.. | 8,993,036 | 1,142,115 | 10,922,154 | 1,365,269 | + 1,929,118 | + 223,154 |
| Lead.....do.... | 37,553,445 | 1,652,352 | 23,572,966 | 1,060,784 | −13,980,479 | − 591,568 |
| Total..... | ..... | 6,985,068 | ..... | 6,982,241 | ..... | − 2,827 |

*Distribution of output of metals in Tintic district in 1911, compared with the output in 1910, by counties.*

| County. | Year. | Number of mines. | Quantity of ore. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Pounds.* | *Pounds.* | |
| Juab | 1910 | 33 | 242,129 | 57,124.63 | 3,743,800 | 8,992,859 | 18,906,002 | $5,176,480 |
| | 1911 | 31 | 300,313 | 72,553.46 | 4,590,023 | 10,918,410 | 14,173,907 | 5,935,152 |
| Utah | 1910 | 7 | 58,502 | 9,164.59 | 1,478,972 | 177 | 18,647,443 | 1,808,588 |
| | 1911 | 7 | 60,078 | 6,462.08 | 924,679 | 3,744 | 9,399,059 | 1,047,089 |

There were 38 properties in 1911 producing 360,391 tons of ore against 40 mines producing 300,631 tons in 1910. The main part of the ore output was shipped to smelters, and the total amounted in value to $6,982,241, or an average of $19.37 per ton. The output of ore in 1910 was valued at $6,985,068, and averaged in value $23.23 per ton. There were 18,376 tons of ore treated at a concentration plant, which yielded lead concentrates, principally carbonates, containing gold and silver, valued at $19,271, or an average of $33.57 per ton. Oxidized iron ore was produced from 3 mines, 2 of which were in Juab County. The ore was valuable principally for flux, and contained small values in gold and silver, for which no payment was made at the smelters. Part of the gold and silver content was estimated from averaging assays of drill samples from the ore body. Altogether there were 30,720 tons of oxidized iron ore mined and shipped. Eleven mines, all in Juab County, produced siliceous shipping ore aggregating 138,652 tons, containing 46,590.67 ounces of gold and 2,311,469 ounces of silver. The Iron Blossom, Centennial-Eureka, and Grand Central were the most important producers, each with an output of over 20,000 tons. Copper ores were shipped from 12 properties—the Centennial-Eureka having the largest output and the Mammoth and the Opohongo having important tonnages—aggregating 69,014 tons in all, and containing 19,202.68 ounces of gold, 870,914 ounces of silver, 7,477,535 pounds of copper, and 335,121 pounds of lead. The lead output was from the ores of the Centennial-Eureka and two other properties. Lead ores were mined from 24 properties, which produced 110,443 tons, containing 12,561.77 ounces of gold, 2,320,831 ounces of silver, 231,587 pounds of copper, and 20,737,726 pounds of lead. The Uncle Sam, Colorado, Sioux, May Day, Iron Blossom, Gemini, Bullion Beck, and Yankee, named in order of production, each produced shipping ore containing over a million pounds of lead. Copper-lead ore was produced from the Undine and Anderson properties. The different kinds of ore produced in the district in 1911 yielded as follows:

*Mine production of Tintic district, Juab and Utah counties, in 1911, by kinds of ore and metal output of each.*

| Kind of ore. | Quantity of ore. | Gold. | Silver. | Copper. | Lead. |
|---|---|---|---|---|---|
| | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Pounds.* | *Pounds.* |
| Siliceous | 180,878 | 47,235.65 | 2,322,068 | 3,207,308 | 2,484,906 |
| Copper | 69,014 | 19,202.68 | 870,914 | 7,477,535 | 335,121 |
| Lead | 110,443 | 12,561.77 | 2,320,831 | 231,587 | 20,737,726 |
| Copper-lead | 56 | 15.44 | 889 | 5,724 | 15,213 |
| Total | 360,391 | 79,015.54 | 5,514,702 | 10,922,154 | 23,572,966 |

The Black Jack mine [1] is opened by a vertical shaft 1,535 feet deep and altogether has 23,770 feet of drifts and raises. The Star shaft is opened to a depth of 800 feet and has 17,005 feet of development. Three leases embracing the Star workings, the lower levels of the Black Jack, and the iron deposits were operated in 1911 and returned a small revenue to the company.

In the Centennial-Eureka mine [2] the developments yielded more ore than was extracted, although the production during the year was heavy, amounting to 108,275 tons. All the ore developments in the mine were made above the water-level. Drifting was started on the 2,000-foot level, which is below the water level, and fair progress was made. The new pumping plant worked well and handled the water without difficulty. Some development work was done on the Bullion Beck and Champion Mining Co.'s property, in which the United States Mining Co. holds a majority interest. Ore was discovered only in bunches. No ore bodies of appreciable size were found.

The Dragon mine yielded 26,658 dry tons of oxidized iron ore, which contained slight values in gold and silver and an average of 56.66 per cent of iron. This ore was valuable at the smelters for flux and without the gold and silver, which was not paid for, was valued at $3.09 per ton.

From the Eagle and Blue Bell mine [3] 5,831 tons of ore were mined and shipped, containing 1,995.22 ounces of gold, 98,738.86 ounces of silver, 726,796 pounds of lead, and 9,747 pounds of copper.

Lessees worked in the Eureka Hill property and shipped crude siliceous ore, carrying values of lead, copper, and silver, and a little gold. The Gemini mine, which is worked to the 1,600-foot level, produced silver-lead ore, most of which was oxidized and contained small quantities of copper and gold. Lessees worked the Carisa mine, producing a copper ore and a lead ore, which carried values in silver and gold. The Ajax shaft, through which the Gold Chain property was operated, produced a gold-silver ore containing copper. The property is developed to a depth of 1,250 feet. The Grand Central mine yielded a large tonnage of siliceous silver ore and some lead ore. It is developed by a vertical shaft 2,300 feet deep. At the Iron Blossom mine [4] developments continue to be promising in the opening of one of the largest bodies of siliceous gold and silver ore that has yet been encountered on the east side of the Godiva Mountain.

> This ore channel has been followed from the No. 3 shaft and connected with the workings of No. 1 shaft, showing a continuous ore body the entire length of the property. * * * The bulk of the ore is siliceous, but a number of the stopes are producing a good grade of lead and copper ores. It is expected that a method of treating the siliceous ores at the mine will soon be devised, instead of shipping the ore to the smelter, thereby costing the company an average of about $10 per ton for smelting, freight, and sampling. The total output of the mine for the fiscal year amounted to 57,491 dry tons of ore containing 14,597.85 ounces of gold, 1,739,777 ounces of silver, 49,037 pounds of copper, and 1,585,968 pounds of lead, valued in all at $1,201,967. The total net returns from this output at the smelter amounted to $603,115.

The Sioux Consolidated mine [5] yielded 7,884 tons of lead carbonates and sulphides with good values in 1911, for which returns of $78,244 were made by the smelters. The shaft was sunk an additional 130

[1] Annual report for year ending Sept. 1, 1911.
[2] Annual report of United States Mining Co. for year ending Dec. 31, 1911.
[3] Annual report of Bingham Mines Co. for year ending Dec. 31, 1911.
[4] Annual report for year ending Dec. 1, 1911.
[5] Annual report for year ending Dec. 31, 1911.

feet, making it altogether 600 feet deep. From this level development was carried on in an easterly direction.

At the Chief Consolidated mine [1] 6,703 tons of ore were mined, yielding 322 ounces of gold, 265,332 ounces of silver, 707,512 pounds of lead, or a total gross value of $25.55 per ton. Freight and smelting charges were $9.96 per ton, leaving a net average value of $15.59 per ton. Drifting was done on the ore zone both north and south on the 1,400-foot level, and similar work was done on the 1,500-foot and 1,600-foot levels, and from these short crosscuts were driven, raises put up, and winzes sunk at intervals to develop the ore channel and ore. Faulting on the south and north ends of the property in workings furnishing the ore seriously affected the production and left the company for the time being dependent on the lower grade ore. Considerable progress has been made in drifting east and west under Eureka in the effort to develop other ore zones.

There were shipped from the Beck Tunnel mine [2] 516.65 tons (dry weight) of ore, having a value of $6,341.22 and containing 44.08 ounces of gold, 11,383 ounces of silver, and 189,966 pounds of lead.

Work in the Colorado mine [3] during 1911 has been prosecuted chiefly in mining known ore bodies and prospecting on the 300-foot level along the channel of ore already mined. There were 19,210 dry tons of ore mined, containing an average of 0.17 ounce of gold, 31.87 ounces of silver, and 10.18 per cent of lead per ton. Smelting and freight charges were $9.27 per ton and total operating costs charged to mining, $3.79 per ton.

Dump ore and ore from the Yankee mine [4] taken out by lessees aggregated 6,584 tons of the former and 987 tons of the latter. The dump ore contained approximately $1.60 in gold and 7 ounces of silver per ton, and 6 per cent of lead; and the lease ore, $2 in gold, 20 ounces of silver, and 30 per cent of lead. During 1911 the shaft was sunk from 1,385 feet to 2,020 feet. In sinking, about 2,000 gallons of water, which came from the 1,300-foot level, were hoisted in 24 hours.

The Lower Mammoth mine yielded copper ores and lead oxidized ores, which carried values in gold and silver. The Mammoth mine yielded three kinds of ore—siliceous ore, copper ore, and lead ore. The siliceous ore carried high average values per ton in silver, gold, and copper, and a little lead. The old Susan property, in the southern part of the district, is opened by a tunnel 800 feet long and produced oxidized lead ores carrying silver and gold values. The Opohongo mine yielded an important tonnage of partly oxidized and siliceous copper ore, carrying good values in gold and silver. The ore also carried from 0.2 per cent to 0.8 per cent in bismuth, 0.3 to 0.4 per cent in arsenic, 0.2 to 0.7 per cent in antimony, 7 to 10 per cent in iron, and 52 per cent in silica. The property is developed by a shaft 1,000 feet deep. The Ridge and Valley mine produced oxidized silver-lead ore, carrying a small quantity of copper. This mine is worked through the Gemini property. Lessees worked the Shoebridge mine and took out some copper ore carrying silver.

Since the Swansea mine [5] began operations in April, 1911, the shaft has been sunk 94 feet, making a total depth of 954 feet, and a station

[1] Annual report for year ending Dec. 31, 1911.
[2] Annual report for year ending June 1, 1911.
[3] Annual report for year ending Nov. 1, 1911.
[4] Annual report for year ending Dec. 31, 1911.
[5] Annual report for year ending Sept. 1, 1911.

has been cut on the 940-foot level. From this point a crosscut encountered the vein on which drifting northward is now in progress and preparations are being made to drift southward. The ore at this point is not of a shipping grade, although there are streaks of ore assaying $2.80 in gold, 80 ounces of silver, and 57 per cent lead. It is expected that these drifts will develop shoots of this ore in paying quantities, in which case, as no mining has yet been done below the 700-foot level south and the 800-foot level north, there are practically 250 feet south and 150 feet north of new ground which can be stoped from this level. A lease is being operated on the 700-foot level and is producing about one car of ore per month.

The Uncle Sam property is opened by an adit 300 feet long connected with the hoist station, from which the mine is opened to a depth of 500 feet by incline shafts. Both oxidized and siliceous lead-silver-gold ores are produced. Siliceous copper ore, containing a little lead with considerable values in silver and a little gold, was produced from the Victoria property, which is opened by a vertical shaft 1,200 feet deep. From the Iron King iron deposits, oxidized iron ore was shipped, averaging 51.5 per cent of iron. This ore is estimated to contain very small quantities of gold and silver, for which no payment is made by the smelters buying the flux.

### MILLARD COUNTY.

Three properties in this county yielded 77 tons of lead sulphide ore, which was shipped directly to smelters. The total average value was $33.14 per ton, containing gold and silver valued at $22 per ton. A small quantity of lead ore, with silver and a trace of gold and copper, was shipped from the Kanosh property, near Kanosh.

### MORGAN COUNTY.

One mine yielded 26 tons of lead ore, which had a total average value of $32.50 per ton and a gold and silver content of $3.27 per ton.

### PIUTE COUNTY.

The operators of 5 mines reported an output of 3,158 tons of ore, which is 3,089 tons less than was produced in 1910. The total average value of the ore in 1911 was $9.44, as against $4.63 in 1910, and the gold and silver value was $9.13, as against $4.38. All but 158 tons of the ore, which was shipped to smelters, was treated at amalgamation and cyanide mills, yielding gold and silver bullion valued at $21,137. The smelting ore shipped, containing gold, silver, and copper, was valued at $8,666, or an average of $54.84 per ton.

*Gold Mountain district.*—The principal producer was the Sevier-Miller property, from which ore was mined and treated in its amalgamation and cyanide mill, producing gold and silver bullion.

*Ohio district.*—The Bully Boy and Webster property yielded gold and silver ore, which was shipped to a copper smelter. The mine is being equipped with an amalgamation and concentration mill, which is expected to be in operation in 1912. The Shamrock property was also a producer of ore containing silver, gold, and a small quantity of lead.

## SALT LAKE COUNTY.

The ore output of this county continues to increase through the operations of steam-shovel mining at Bingham. The total quantity of ore mined in the county increased from 5,442,258 tons mined by 52 producers in 1910 to 6,051,042 tons mined by 49 producers in 1911. The total average value increased from $3.49 to $3.73 per ton, and the gold and silver value from $0.52 to $0.63 per ton. The bulk of the ores, or 5,370,639 tons, was treated at concentration mills and 666,546 tons were shipped crude directly to smelters. The amalgamation and cyanide processes were used to treat 10,300 tons of ore, yielding bullion which was valued at $84,853.

*Big and Little Cottonwood districts.*—The combined production of these districts for seven years is given in the table following:

*Number of mines producing in Big and Little Cottonwood districts, quantity of ore sold or treated in 1905–1911, and total content of gold, silver, and associated metals.*

| Year. | Number of mines producing. | Quantity. | Gold. | Silver. | Copper. | Lead. | Total value. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | |
| 1905 | 6 | 26,003 | 950.00 | 371,683 | 811,639 | 1,702,258 | $450,756 |
| 1906 | 10 | 20,801 | 762.07 | 345,102 | 1,193,743 | 1,922,276 | 586,933 |
| 1907 | 11 | 19,896 | 976.93 | 399,417 | 1,074,238 | 2,337,92 4 | 622,568 |
| 1908 | 21 | 5,866 | 321.35 | 63,246 | 269,212 | 603,840 | 101,061 |
| 1909 | 15 | 13,208 | 335.72 | 158,867 | 1,842,711 | 332,475 | 343,400 |
| 1910 | 17 | 14,203 | 381.87 | 202,010 | 804,018 | 1,102,907 | 267,617 |
| 1911 | 12 | 6,040 | 139.17 | 158,448 | 407,719 | 1,043,608 | 184,783 |

The largest producer in the Big Cottonwood section in 1911 was the Black Bess property of the Utah Mines Coalition Co., and in the Little Cottonwood district the Columbus Extension and the Columbus Consolidated properties were the main producers. The Cardiff and Mountain Chief mines yielded a lead and copper sulphide ore containing silver and gold. The property is opened by an adit 1,350 feet long. Shipments of lead-silver ores, carrying a little copper, were made by lessees from the Maxfield group. From the Black Bess mine, oxidized lead-silver ores, carrying copper and gold, were shipped. The property is opened by a tunnel 3,772 feet long and 1,363 feet of crosscuts and drifts. The old Jefferson mine, worked by the Wasatch-Utah Co., yielded ore from which gold and silver bullion and some concentrates, containing copper, gold, and silver, were extracted. The property is equipped with a 5-stamp amalgamation mill and concentrating tables. The Silver King group, operated by the Alta Consolidated Co., is opened by a main adit 1,000 feet long and has 1,000 feet of drifts and crosscuts. A lead-copper sulphide ore, containing silver and a little gold, was produced. At the Columbus mine some concentrate, carrying lead and copper, was produced, but the largest shipments consisted of copper-lead ore, carrying good values in silver and a little gold, which was shipped directly to the smelter. The White Captain property, operated by the Columbus Extension Co., yielded a copper ore and a lead ore, each carrying values in gold and silver. Other producers were the Peruvian, Alta-Hecla, and Kennebec properties.

*West Mountain or Bingham district.*—With the largest record of ore production in Utah, the output of this district in 1911 aggregated 6,044,893 tons, valued at $22,373,132 and averaging in value $3.70 per ton.

*Production of gold, silver, copper, lead, and zinc in the West Mountain or Bingham district, Salt Lake County, Utah, in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 85,526.61 | $1,767,992 | 110,389.00 | $2,281,943 | + 24,862.39 | + $513,951 |
| Silver.....do.... | 1,800,410 | 972,222 | 2,786,810 | 1,477,009 | + 986,400 | + 504,787 |
| Copper.....pounds.. | 113,725,280 | 14,443,110 | 129,995,865 | 16,249,483 | +16,270,585 | +1,806,373 |
| Lead.....do.... | 30,271,016 | 1,331,925 | 46,576,337 | 2,095,935 | +16,305,321 | + 764,010 |
| Zinc.....do.... | 3,572,347 | 192,907 | 4,715,121 | 268,762 | + 1,142,774 | + 75,855 |
| Total..... | ..... | 18,708,156 | ..... | 22,373,132 | ..... | +3,664,976 |

The number of mines producing and the production of ore and its content in this district for seven years is shown in the following table:

*Number of mines producing and quantity of ore sold or treated in West Mountain or Bingham district in 1905–1911, and total content of gold, silver, copper, lead, and zinc.*

| Year. | Number of mines producing. | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|---|
| | | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1905... | 21 | 1,012,009 | 63,701.00 | 1,980,583 | 39,219,734 | 23,494,879 | ..... | $9,735,627 |
| 1906... | 25 | 996,121 | 78,986.03 | 1,927,350 | 39,424,276 | 22,927,661 | ..... | 11,839,873 |
| 1907... | 29 | 1,503,082 | 75,730.24 | 1,786,580 | 45,431,964 | 21,971,064 | ..... | 12,995,485 |
| 1908... | 27 | 2,691,640 | 60,382.69 | 1,053,146 | 71,155,740 | 15,169,518 | ..... | 11,836,067 |
| 1909... | 24 | 4,166,992 | 73,599.47 | 1,615,394 | 92,560,340 | 30,365,819 | 649,542 | 15,735,090 |
| 1910... | 31 | 5,427,953 | 85,526.59 | 1,800,410 | 113,725,280 | 30,271,016 | 3,572,347 | 18,708,156 |
| 1911... | 32 | 6,044,893 | 110,389.00 | 2,786,810 | 129,995,865 | 46,576,337 | 4,715,121 | 22,373,132 |

The ores shipped to smelters aggregated 661,852 tons, as against 496,773 tons in 1910 and 626,068 tons in 1909. The concentrating ores aggregated 5,369,388 tons, as against 5,427,953 tons treated in 1910, and the concentrates produced were 271,932 tons in 1911, as against 237,541 tons in 1910. A new venture was started in the treatment of the siliceous silver-gold ores of the old Telegraph mine by the cyanide process, and it is reported to be successful. The crude smelting ore, 661,852 tons in quantity, which was largely low-grade copper sulphides, contained 61,466.24 ounces of gold, 1,896,543 ounces of silver, 26,028,162 pounds of copper, 29,913,596 pounds of lead, and 155,003 pounds of zinc, valued in all at $6,884,255, or an average of $10.40 per ton. The concentrates produced from ores mined in the camp, 271,932 tons in quantity, contained 46,148.06 ounces of gold, 760,142 ounces of silver, 103,173,816 pounds of copper, 16,662,741 pounds of lead, and 4,560,118 pounds of zinc, valued in all at $15,263,317, or an average of $56.13 per ton. Credited to the district are 3,453 tons of old smelter cleanings shipped from one of the dismantled smelters. The zinc was produced mainly from the prop-

erties of the United States Co., and some shipments were made from the property operated by the Ute Copper Co. The Utah Leasing Co. shipped silver-gold bullion extracted from siliceous ores mined from the Telegraph property and treated in its cyanide mill. The number of mines and the different kinds of ore produced in 1911 are given in the following table:

*Output of ore and production of metals in Bingham district, Utah, in 1911, by kinds of ore.*

| Kind of ore. | Number of mines producing. | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Siliceous | 4 | 14,181 | 1,712.87 | 122,114 | 29,811 | 241,378 | ..... |
| Copper | 12 | 5,803,186 | 96,349.81 | 1,434,936 | 127,767,904 | 2,574 | ..... |
| Lead | 25 | 131,107 | 8,691.53 | 968,018 | 1,757,272 | 34,430,315 | ..... |
| Copper-lead | 1 | 187 | 58.13 | 1,839 | 70,507 | 68,972 | ..... |
| Lead-zinc | 3 | 96,232 | 3,576.66 | 259,903 | 370,371 | 11,833,098 | 4,715,121 |
| Total | [a] 45 | 6,044,893 | 110,389.00 | 2,786,810 | 129,995,865 | 46,576,337 | 4,715,121 |

[a] There were only 32 producing mines, but more than one kind of ore was mined at several of them.

Low-grade porphyry ore containing disseminated copper aggregated 5,231,791 tons, and constituted 86.5 per cent of the total tonnage of the district. It was the source of 78.8 per cent of the copper, 37.2 per cent of the gold, and 14.4 per cent of the silver recovered. In 1910 the tonnage aggregated 4,780,949 tons, which was 88 per cent of the total tonnage of the district, and contained 80 per cent of the copper, 47 per cent of the gold, and 21 per cent of the silver. These ores were mined chiefly by steam shovels and hauled by rail from the mines to the milling plants owned by the Utah Copper Co. A large tonnage of monzonite porphyry ore was treated in 1911 at the Ohio mill, situated at Lark. As a means of showing the disposition of the ores mined in the district, the following flow sheet is given:

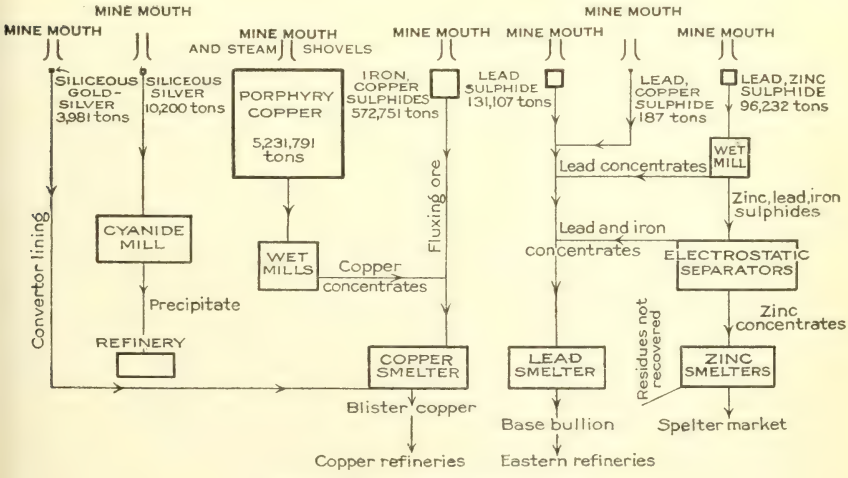



FIGURE 2.—Flow sheet of Bingham ore.

The low-grade copper-bearing porphyry ore was all treated in 1911 at the two wet concentration mills of the Utah Copper Co. near Garfield, and at the Ohio concentrator at Lark. The ore averaged per ton 16 cents in gold, 0.076 ounce of silver, 19.59 pounds of copper, yielding 207,472 tons of copper concentrate, averaging $4.06 in gold, 1.94 ounces of silver, and 494.11 pounds of copper per ton. These concentrates were all smelted at the Garfield smelting works. Fluxing ore was shipped, consisting of iron-copper sulphides, aggregating 572,751 tons, containing low values in gold and silver, averaging about 2 per cent of copper. This, with 3,981 tons of siliceous gold and silver ore, was purchased by the copper smelting plants at International and Garfield, Utah, where the copper is converted to blister and shipped to eastern refineries. The lead-sulphide ores aggregating 131,107 tons, were shipped with lead and iron concentrates produced at wet and dry concentration mills to Murray, Midvale, and International smelters, where the ore and concentrates are roasted and smelted, yielding lead bullion containing gold and silver. This bullion is shipped to refineries at Grasselli, Ind., and Perth Amboy, N. J. The lead-zinc sulphide ores produced at Bingham were mined mainly from one group of mines and aggregated 96,232 tons. This ore was first treated in wet concentration mills, yielding lead concentrates and a zinc-lead-iron sulphide middling, which was re-treated in a mill using Huff electrostatic dry concentrators, which yielded lead-iron concentrate and a zinc concentrate. The former was treated at local smelters and the latter, averaging about 45 per cent of zinc, was shipped to eastern refineries where the zinc concentrate was distilled in retorts to spelter, and the residues, containing part of the gold, silver, copper, and lead, which are usually saved at other plants and shipped to lead smelters, are worthless on account of having been mixed with higher grade zinc ores carrying only zinc.

The total amount of underground work done in the original Utah Copper group [1] during 1911 was 8,930 feet, making a grand total done since the mine was opened of 190,271 feet, or 36.04 miles. * * *.

The cost of underground development for the year amounted to 15.66 cents per ton for all ores mined from underground. Development costs applying to all ores shipped from the mines, both underground and surface operations, was 4.11 cents per ton. The cost of churn drill development during the year amounted to 1.20 cents per ton on the total ore produced from both sources. The cost of both underground and surface development, therefore, amounted to 5.31 cents per ton of ore mined. The whole of this cost was charged to operations, and is included in the per ton mining costs for the year, hereafter stated. * * * After deducting all the ore that had been mined from the property previous to January 1, 1912, there yet remained 301,500,000 tons of fully developed and partially developed ore, of which amount 229,830,000 tons were fully developed and 71,670,000 tons partially developed. The above-mentioned tonnage of developed and partially developed ore includes about 26,790,000 tons of partially developed ore in the slopes of the steam shovel workings. Of the fully developed ore, the average assay of 62,040,000 tons is 2 per cent copper; the average assay of an additional 92,130,000 tons is 1.60 per cent copper; and the average assay of the remaining 75,660,000 tons is 1.30 per cent copper. The average assay of 71,670,000 tons of partially developed ore is 1.28 per cent copper, making the average assay of the 301,500,000 tons of developed and partially developed ore 1.532 per cent copper. As it will not be possible in mining operations to keep the ore absolutely clean, the average assay of all the ore is considered as 1.50 per cent copper. In this connection it is of interest to note that during the entire life of both the Utah and Boston mines there was mined and milled previous to January 1, 1912, a total o

[1] Annual report Utah Copper Co. for year ending Dec. 31, 1911.

15,885,521 tons of ore, having an average assay of 1.6018 per cent copper. * * * Underground mining operations at the Boston mine were continued throughout the year, and for a portion of the time at irregular intervals some underground mining was done in the original Utah mine on the east side of Bingham Canyon. Of the total ore mined during the year, 74 per cent was obtained by steam shovels from the original Utah Copper mine; 4 per cent was mined underground in the Utah mine; and 22 per cent was mined underground in the Boston mine. The average cost of steam shovel mining for the year was 33.73 cents per ton, of which 9.12 cents was charged to cover the cost of prospecting with churn drills and of stripping expense, leaving a cost, including all general charges, except development and stripping expense, for producing shovel ore of 24.61 cents per ton. The average cost of underground mining for the year was 68.35 cents, of which amount 15.66 cents was charged to cover the cost of underground developemnt. The cost of underground mining at the Boston mine was considerably less than at the Utah mine, on account of the greater rate of tonnage at which the operations at the former point were conducted. The average cost of mining all the ore obtained from both surface operations and underground operations during the year was 44.79 cents per ton, of which 12.81 cents was charged to cover prospecting with churn drills, underground development, and stripping expense, leaving a net cost of actual mining, including general and fixed charges, of 31.98 cents per ton. * * * The total ore treated at both milling plants in 1911 was 4,680,801 tons, as compared with 4,340,245 tons for the previous year. The Magna plant milled 3,725,404 tons, an increase of approximately 515,000 tons as compared with the previous year. The Arthur plant, the full capacity of which was not required throughout the year, milled 955,397 tons, an increase of about 18,000 tons as compared with the previous year. The Magna plant has readily handled 1,000 tons per section per day during periods when the ore supply was plentiful and regular, thus proving its ability to treat 12,000 tons daily. The new sections of the Arthur plant, under like conditions, milled at the rate of 9,000 tons for the entire plant, and it is therefore demonstrated that the two plants will, when the Arthur is completed, have a combined capacity sufficient to economically mill 21,000 tons per day of the same grade and character of ore milled during the past year. * * * The average copper content of the ore treated at both plants was 1.51 per cent, as compared with 1.54 per cent for the year 1910. The average recovery at both plants was 69.53 per cent, corresponding to 21.03 pounds of copper per ton, as compared to an average extraction of 66.55 per cent and a recovery of 20.51 pounds per ton for the previous year. The average extraction at the Magna plant was 69.28 per cent and at the Arthur 70.49 per cent. * * * The average cost of milling at both plants was 41.68 cents per ton, as compared to 46.63 cents for the previous year. The milling cost at Magna was 40.06 cents and at Arthur 48.01 cents per ton. * * * The total production of copper contained in concentrates from both plants for the year was 98,436,224 pounds, as compared to 89,019,511 pounds for the previous year. The average grade of concentrates produced was 25.62 per cent, as compared with 27.28 per cent for the year 1910. The reduction in average grade of concentrates was due principally to the treatment of ores mined from underground in the Boston Consolidated area, which contained a somewhat higher percentage of iron than ores from the Utah Copper area.

The Ohio Copper Co.[1] treated at its concentration mill during six months 311,067 tons of low-grade copper ore, which contained an average of 1.176 per cent of copper, of which there was an average loss of 44.13 per cent in concentration. An average of 33.74 tons of ore made 1 ton of copper-iron sulphide concentrate, of which 9,219 tons were produced, from which the smelter returned 3,754,866 pounds of copper, or an average of 20.36 per cent of metal.

There was mined and shipped from the Highland Boy[2] property to the International smelter at International, Utah, 162,522 dry tons of copper-iron sulphide ore, averaging 2.891 per cent of copper, 0.0936 ounce of gold, and 0.9815 ounce of silver; also 7,793 dry tons of first-class lead sulphide ore, averaging 22.164 per cent of lead, 0.0854 ounce of gold, 5.413 ounces of silver, and 0.655 per cent of copper.

At the Winnamuck mill 2,524 tons of ore yielded 512 dry tons of lead concentrate averaging 21.984 per cent of lead, 0.075 ounce of gold, 5.038 ounces of silver, and 0.609 per cent of copper. In addition to the above there was shipped to the smelter at Gar-

[1] Semiannual statement for six months ending Mar. 31, 1912.
[2] Annual report Utah Consolidated Mining Co. for year ending Dec. 31, 1911.

field 3,238 dry tons of furnace bottoms and cleanings from the old smelter, and these yielded 704,800 pounds of copper, 1,460 ounces of gold, and 16,803 ounces of silver. * * * The development of copper ore during the past year has not been satisfactory as to grade. All of the new ore encountered has been in the lower levels—namely, below the eighth—and the ore bodies, though of a large size, are low in value. In the upper levels no new ore was found. However, in this part of the mine several crosscuts are now approaching favorable territory. The lead ore bodies were the most important opened up, and the work now progressing is in good ore. The principal lead ore body is on the California level (150 feet below the top level) at the contact of the upper limestone (Yampa limestone) and quartzite. The ore extends along the contact for 300 feet. * * * The ore here is 4 feet wide, averaging 14.6 per cent of lead, 0.06 ounce of gold, 3.6 ounces of silver, and 0.8 per cent of copper. There is in sight in the mine 239,650 tons of copper ore, 23,785 tons of first-class lead ore, and 12,000 tons of second-class lead ore, which will require concentration.

Regular shipments of ore began in April from the Utah Apex mine,[1] which had curtailed production to carry on further development work in the south branch of the Parvenu tunnel, where a new body of lead ore conservatively estimated to be 400 feet long, 100 feet wide, and with an average thickness of 60 feet had been discovered. The concentration mill on the property is operated on second-class ore from the mine.

Shipments of silver-lead and copper-iron sulphide ores have been going forward from the Dalton & Lark mine [2] to the valley smelters during 1911, while the Commercial mine, producing exclusively copper-iron sulphides, has been producing shipping ore for nine months only, commencing in April. Following is a statement of wet and dry tons, showing metal content and gross value of the product, a substantial increase over the output of 1910:

*Operations of Dalton & Lark and Commercial mines, Utah, in 1911.*

| Property. | Metal. | Quantity. | | Gross value. |
|---|---|---|---|---|
| | | *Wet tons.* | *Dry tons.* | |
| Dalton & Lark | Lead | 17,751.89 | 17,056.089 | $343,978.26 |
| Do | Copper | 7,199.46 | 7,010.160 | 41,765.56 |
| | | 24,951.35 | 24,066.349 | 385,743.82 |
| Commercial | do | 22,635.37 | 22,016.682 | 74,226.05 |
| Total | | 47,586.72 | 46,083.031 | 459,969.87 |

The total metal content of the above ores was 3,980.73 ounces of gold, 354 855.06 ounces of silver, 5,792,441 pounds of lead, and 790,818 pounds of copper.

In the upper workings of the Dalton & Lark and Commercial mines a limited amount of mining was performed by lessees, and from the old mine dumps of the former mine material was shipped and treated in the old Winnamuck mill at Bingham. Most of the ore mined by the company, or 13,759 tons, came from the Lead mine, the Lark vein produced 3,368 dry tons of lead and copper ore, and the Miner's Dream vein 6,938 tons of lead and copper ore. * * * The Commercial mine has been shipping about 110 tons of low-grade copper-iron sulphides a day.

The Utah Metal Mining Co.[3] has driven its tunnel 6,796 feet from the Tooele side of West Mountain to the Bingham side and has yet to drive about 4,200 feet.

To hasten the work the tunnel is being driven from both ends, and already 548 feet have been driven from the Bingham side of the mountain. * * * It is expected

[1] Annual report for year ending Aug. 31, 1911.
[2] Annual report Bingham Mines Co. for year ending Dec. 31, 1911.
[3] Report of the directors of the Utah Metal Mining Co. for year ending Dec. 31, 1911.

that mineral will be encountered in the Mountain Maid claim 700 feet beyond the present Bingham face. * * * The tunnel has been driven mainly to supply space on the Tooele side of the Mountain to dump waste, and, with water resources capable of supplying a concentrating mill of considerable size, holds a commanding position in relation to mining operations conducted by the different companies in upper Bingham camp.

The Bingham-New Haven mine[1] during the year 1911 produced 73,740 tons of copper-iron sulphide ore, containing 5,983 ounces of gold, 344,130 ounces of silver, and 6,520,295 pounds of copper. Lead-sulphide ore was also mined, aggregating 8,966 tons, containing 471 ounces of gold, 94,036 ounces of silver, 277,793 pounds of copper, and 3,844,276 pounds of lead. At the concentration mill, which was treating an average of about 90 tons of ore a day, 2,719 tons of lead-sulphide concentrates were saved from ore concentrating two tons into one of concentrate. The concentrates contained 286 ounces of gold, 16,991 ounces of silver, 110,158 pounds of copper, and 803,721 pounds of lead. Dividends were paid during the fiscal year amounting to $228,689.

But little work was performed on the Yosemite mine in 1911, during which 1,282 tons of copper sulphides were shipped, bringing smelter returns of $9,349.54. The old stopes above the Paradox tunnel in the Cluster claim were leased and 871 tons of lead ore shipped by the lessees.

The Last Chance, Queen, New England, North Utah, Silver Shield, Yampa, Niagara, and Ute copper properties were operated.

### SEVIER COUNTY.

There was mined from the Iron Cap property, in the Sevier district, oxidized iron ore, shipped to the smelters for flux. This ore is reported to contain small values in gold and silver, which were estimated, and the metal content is included in the report.

### SUMMIT COUNTY.

Twenty-two mines, situated in the Park City region of this county, yielded 236,867 tons of ore, which is 77,636 tons greater than in 1910, when only 16 producers reported. The total average value of the ore decreased from $17.42 to $16.22 per ton in 1911, and the gold and silver value from $7.62 to $6.79 per ton. The output is almost equally divided between lead ore and lead-zinc ore. The Park City district extends into Wasatch County, and reviews for the two counties are combined in giving an account of the operations of the Park City region for 1911.

The mines of Snake Creek and Uinta districts in the Park City region produced 296,350 tons of ore in 1911, against a production of 215,339 tons in 1910 and of 196,172 tons in 1909. The crude ore shipped directly to smelters consisted mainly of mixed carbonates and sulphides and aggregated 42,589 tons, containing 2,509.12 ounces of gold, 1,764,930 ounces of silver, 535,313 pounds of copper, and 17,951,719 pounds of lead, valued in all at $1,862,023, or an average of $43.72 per ton. The remainder of the ore mined, aside from 5 tons tested at a gold and silver mill, aggregated 204,007 tons, and yielded 63,149 tons of concentrates—including concentrate from 49,749 tons

[1] Annual report Bingham-New Haven Copper & Gold Co. for year ending Sept. 1, 1911.

of old tailings—containing 2,434.70 ounces of gold, 1,663,503 ounces of silver, 745,877 pounds of copper, 29,685,923 pounds of lead, and 8,596,564 pounds of zinc (spelter), valued in all at $2,851,091, or an average of $45.15 per ton. In 1910 the average value of the shipping ore was $47.21 per ton and of the concentrate, $43.84 per ton. There were mined three classes of ore, of which lead-zinc ore made up the largest part of the tonnage, or 177,387 tons, containing 1,379.2 ounces of gold, 1,095,794 ounces of silver, 745,399 pounds of copper, 21,729,008 pounds of lead, and 8,309,376 pounds of zinc. Lead ores aggregating 110,290 tons, contained 3,268.06 ounces of gold, 2,241,47 ounces of silver, 533,212 pounds of copper, and 25,895,945 pounds of lead. From 4,236 tons of dry or siliceous ore there were recovered 295.20 ounces of gold, 90,889 ounces of silver, 2,101 pounds of copper and 3,088 pounds of lead.

The metallic production of the Park City region for 1910 and 1911 is shown in the following table:

*Mine production of gold, silver, copper, lead, and zinc in Park City mining region, Summit and Wasatch counties, Utah, in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 4,467.48 | $92,351 | 4,944.12 | $102,204 | + 476.64 | + $9,85 |
| Silver.....do.... | 2,571,771 | 1,388,756 | 3,428,651 | 1,817,185 | + 856,880 | +428,42 |
| Copper.....pounds.. | 1,423,629 | 180,801 | 1,281,190 | 160,149 | − 142,439 | − 20,65 |
| Lead.....do.... | 38,129,761 | 1,677,709 | 47,637,642 | 2,143,694 | +9,507,881 | +465,98 |
| Zinc.....do.... | 9,437,992 | 509,651 | 8,596,564 | 490,004 | − 841,428 | − 19,64 |
| Total..... | ..... | 3,849,268 | ..... | 4,713,236 | ..... | +863,96 |

As a method of showing the disposition of the ores mined in the Park City region, the following flow sheet is given:

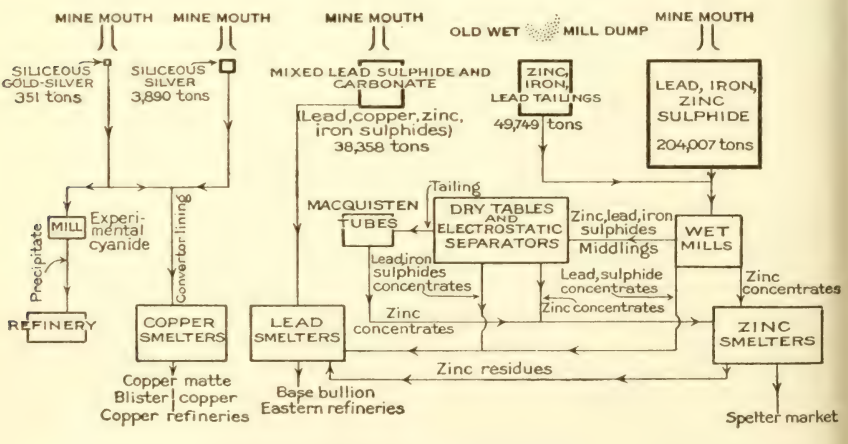



FIGURE 3.—Flow sheet of Park City ore.

Of the total ore produced in the Park City region, 68.8 per cent, r 204,007 tons of lead-iron-zinc sulphide ore, was of milling grade nd was treated at wet concentration mills, making lead-zinc mid-lings and concentrates and a lead concentrate. In 1911 the bulk f the zinc concentrate and middlings was shipped directly to zinc melters and refiners, and only a small quantity of middlings was econcentrated in the dry mills, using Huff electrostatic separators t Midvale, and dry-sizing apparatus with dielectric separators and utton dry tables at Park City. At the close of 1911 operations ere started for the treatment of the tailing of this dry mill with the Iacquisten tube flotation process. The concentrates resulting from his treatment and from the dry mill went directly to the zinc refin-rs. Old tailings taken from along Silver Creek or caught from the resent discharge of the wet mills operating in the region in 1911 ere reconcentrated at small plants, which treated approximately 9,749 tons of tailing and produced 6,743 tons of middlings. The iddlings, averaging 14 cents in gold, 3.99 ounces of silver, 1.92 ounds of copper, 52.45 pounds of lead, and 530.41 pounds of zinc spelter), per ton, were re-treated at dry mills equipped with electro-atic separators, which yielded a zinc concentrate, averaging about 5 per cent of zinc, that was shipped to eastern refineries, and a lead nd iron concentrate, carrying about 15 ounces of silver per ton and 7 per cent of lead, to lead smelters in Utah. Lead carbonate and ulphide concentrates produced from the concentration of the lead-on-zinc ores aggregated 48,037 tons. Of the siliceous silver ores hipped to copper smelters and used for converter lining, there were ,231 tons, containing an average of $1.44 in gold, 21.43 ounces of lver, 0.50 pound of copper, and 0.73 pound of lead per ton. Gold nd silver siliceous ores and the siliceous silver ores will likely all be reated at Park City by a modification of the chlorination process. ests were made in 1911 to that end.

From the Silver King Coalition [1] mines there were mined 86,387 ons of second-class ore, which concentrated 6.12 tons into 1 ton of oncentrate, or 14,115 tons, containing 1,174 ounces of gold, 715,367 unces of silver, and 9,661,137 pounds of lead. Crude lead carbonate nd sulphide ore was shipped directly to the smelter, aggregating 1,506 tons, containing 1,185 ounces of gold, 1,076,711 ounces of sil-er, and 12,194,390 pounds of lead. The concentrates averaged .083 ounce of gold and 50.71 ounces of silver per ton, and 34.24 er cent of lead. The crude shipping ore averaged 0.05 ounce of old and 50.06 ounces of silver per ton, and 28.35 per cent of lead.

The Silver King Consolidated mine [2] yielded 469 dry tons of ore veraging 40 ounces of silver and 0.07 ounce of gold per ton, and 7.2 per cent of lead and 0.6 per cent of copper.

Development work was confined to the Andes claim on the 1,500-foot level, starting the quartzite and running northwest to the limestone quartzite contact, and during his work ore has been taken from various raises driven on the fissures or parallels of he Silver King Coalition ore zone extending into Consolidated ground. The per-stence, size, and value of ore shoots in this section of the Park City camp have been emarkable. Of the surrounding ore bodies, the main ore shoot in the Silver King oalition ground, lying just south of the Consolidated, has been followed and mined r 8,000 feet, and according to the latest report of the Coalition Co. has produced an verage of 59.26 tons of ore per running foot with an average net value of $38.54 per ot.

[1] Annual report for year ending Apr. 30, 1912.
[2] Annual statement to stockholders for year ending Feb. 1, 1912.

During 1911 there were mined from the Daly West mine [1] 7,083 dry tons of first-class ore and 81,058 dry tons of second-class ore. A portion of the upper workings above the 1,200-foot level was mined by lessees, and the lower levels by the company. Lessees also mined in the Quincy workings and are said to have contributed materially to the total output of the mine. The milling ore came principally from the 1,800-foot level, which yielded 61,484 tons; the 1,700-foot level, 10,574 tons; and the 1,900-foot level, 9,000 tons. Development and exploratory work on the 2,100-foot level is to ascertain by crosscutting whether the ore bodies reach this level. The quantity of ore delivered to the mill aggregated 81,058 dry tons, from which 1,137 tons of waste was sorted, leaving 79,921 dry tons, which averaged 9.68 per cent (wet assay) of lead, 9.3 per cent of zinc, 2.58 per cent of silica, and 6 per cent of iron, and 0.15 ounce of gold and 10.9 ounces of silver per ton. From this ore 22,908 dry tons of lead concentrate and 6,237 dry tons of zinc concentrate were produced. The assays for crude ore and concentrate are given in the table following.

*Average assay per ton of mill ore, crude ore, and concentrates treated and shipped by the Daly West Mining Co., Utah, in 1911.*

| Kind of material. | Dry ore. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Ore treated at mill | 79,921 | ..... | 10.90 | ..... | 9.68 | 9.30 |
| Crude ore shipped | 7,083 | 0.0479 | 60.35 | 2.12 | 19.21 | ..... |
| Lead concentrates shipped | 22,908 | .0378 | 29.51 | 1.25 | 31.29 | 16.30 |
| Zinc concentrates shipped | 6,237 | .0250 | 15.11 | 1.08 | 5.67 | 34.98 |

The tailings from the mill averaged 1.37 ounces of silver per ton, and 0.25 per cent of lead and 1.79 per cent of zinc. The company in 1911 paid dividends amounting to $162,000 and has made $6,363,000 in dividends since 1899.

The total amount of prospecting and exploratory work in the Daly-Judge mines [1] during 1911 aggregated 7,497.5 feet, and the total production was 51,875 tons of milling ore and 7,586 tons of shipping ore.

The mill treated 51,875 tons of ore, dry weight, from which 12,237 tons of lead concentrates and 3,919 tons of zinc middlings were made. There were concentrated 4.2 tons of crude ore into 1 ton of lead concentrates, and all products combined, 3.2 tons. Two Janey-Richards classifiers were installed during the year—1 to treat the table feed and 1 to treat the zinc middlings. This equipment is making a well-classified feed for the tables, resulting in a closer saving and a rejection from the first tables. A higher grade of zinc product is being made from the zinc tables. Where a 30 per cent product was formerly made, it is now possible to make a 40 per cent to a 45 per cent product. * * *

The average assay of the crude ore and concentrates follows:

*Average metallic content per ton of crude ore and concentrates of Daly-Judge Mining Co., Utah, in 1911.*

| Kind of material. | Dry ore. | Gold. | Silver. | Lead. | Copper. | Zinc. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Crude ore shipped | 7,586 | 0.077 | 32.44 | 23.56 | 1.09 | 12.92 |
| Lead concentrates shipped | 12,237 | 0.036 | 23.37 | 24.74 | .60 | 14.63 |
| Zinc middlings shipped | 2,783 | 0.020 | 10.19 | 6.84 | ..... | 34.04 |

[1] Annual report for year ending Dec. 31, 1911.

Milling and crude shipping ore was mined in the largest quantity from the "back" and "middle" veins, 1,200-foot and 1,260-foot levels. Drifting on these levels has been done along the Ontario quartzite contact to the extent of 850 feet during 1911. There were mined from these levels 22,929 cars [1] of milling ore and 1,650 cars of shipping ore. From the Daly vein on the 700-foot level 3,674 cars were mined, carrying contents high in copper and silver, which with the resinous variety of zinc make an excellent milling ore. The stope from which this ore came is now at least 100 feet along the strike of the fissure and in its widest place is 40 feet wide. On the 1,100-foot level of the Daly vein 11,611 cars of milling ore and 652 cars of shipping ore were taken from the stopes opened from a continuation of the ore found on the 1,200-foot level. The "back" vein on the 1,400-foot and 1,500-foot levels yielded 13,684 cars of milling grade and 729 tons of shipping ore from the contact ore body, which has been explored for further ore 600 feet southwest of the Daly West line and with further development may be found to be ore bearing again.

The American Flag mine, which is opened by a vertical shaft 1,070 feet deep, yielded mostly siliceous gold-silver ores from the upper levels of the property. Experimental shipments of ore, containing zinc, were made to the United States concentration plant at Midvale from the California-Comstock property, which is opened by a vertical shaft 240 feet deep, 300 feet of drifts, and an adit 3,500 feet long. The Grasselli Co. operated its wet mill on a large tailing dump from February until November, producing some concentrate which was treated in the dry mill belonging to the company near Park City. The New York mine, which is opened by a vertical shaft 1,000 feet deep, produced shipping lead-silver ore containing values in copper and gold. The lessees of the Ontario property shipped largely siliceous ores, carrying gold and silver. It is the purpose of the lessees to build a milling plant for the treatment of the ores, probably by the chlorination process.

Expensive damage suits brought in the past by farmers whose lands along Silver Creek have been covered with tailings from the mills at Park City are now avoided by several companies combining in the purchase of 700 acres of land conveniently located for impounding all the tailings and reconveying the settled water back to the creek.

### TOOELE COUNTY.

Twenty-one producers mined 291,131 tons of ore during 1911, which is 23,351 tons less than was mined by 22 operators in 1910. The average value of the ore per ton increased from $4.44 in 1910 to $5.33 in 1911, and the gold and silver value decreased from $2.62 to $2.61 per ton. The bulk of the ore, or 252,688 tons, was treated in cyanide mills and yielded 27,571.67 ounces of gold and 305 ounces of silver, valued at $570,119. Shipments were made of lead sulphide and zinc carbonate ores, aggregating 34,790 tons, which contained $14,955 in gold, 276,089 ounces of silver, 293,106 pounds of copper, 11,741,293 pounds of lead, and 4,452,290 pounds of zinc, valued, in all, at $980,059, or an average of $28.17 per ton. In addition to these shipments, old slags from the old Chicago smelter dump were shipped, yielding some lead and small values in gold and silver.

[1] A mine car of milling ore weighs about 1 ton and a car of crude shipping ore from 1½ to 2 tons.

*Camp Floyd district.*—Three producers in 1911 reported the treatment by the cyanide process of 256,288 tons of ore and old tailings, which contained $569,957 in gold and 305 ounces of silver, valued in all at $570,119, or an average recovery of $2.22 per ton. The Consolidated Mercur was the largest producer of gold, with an output of $545,965.

At the Daisy property the mill was shut down after operating in January and February and treating about 100 tons of $3 ore per day by the cyanide process. Some tailings from the old Manning mill were treated by lessees, and this plant was also closed in 1911.

According to a special statement dated May 11, 1912, issued by the Consolidated Mercur Gold Mines Co., the ore in the property will soon be exhausted and it is expected that operations will cease before the end of 1912, provided no favorable developments take place within the next few months.

*North Tintic district.*—Lessees worked on the New Bullion property, which yielded about 100 tons of lead ore carrying silver and small gold values. The Scranton was the largest producer of ore, three different products having been shipped. The zinc-lead ore from this property is said to be used at the smelter largely for the manufacture of pigments at an eastern refinery. The lead ores are shipped to the smelters in Utah.

*Ophir district.*—Nine mines in 1911 produced 15,666 tons of ore, all of which was of shipping grade, and contained $5,014 in gold, 163,278 ounces of silver, 276,640 pounds of copper, 4,436,566 pounds of lead, and 333,876 pounds of zinc, valued in all at $344,808, or an average of $22.02 per ton. The largest shipments of lead ore came from the Cliff mines, and contained considerable values in silver, with a little copper and gold. The Commodore, Kearsarge, Chloride Point, Mono, and Hidden Treasure properties were also important producers, the latter yielding oxidized zinc ores in addition to the lead ores. According to the annual statement of the Lion Hill Co., several carloads of high-grade ore were shipped during development work. The net average content of the ore was 105 ounces of silver and $3.39 in gold per ton, and 4.5 per cent of lead.

*Rush Valley district.*—Shipping ore was produced from five properties in 1911, aggregating 10,107 tons, containing $9,868 in gold, 102,863 ounces of silver, 12,689 pounds of copper, and 4,969,476 pounds of lead, valued in all at $289,597, or an average of $28.65 per ton. The greatest part of the output came from the Honcrine mine, operated by the Bullion Coalition Mines Co. The ore was chiefly lead sulphide, carrying considerable silver values, with some copper and gold. The next important production came from the Galena King property, which yielded oxidized lead ores, with considerable values in silver, some gold, and a little copper.

*Silver Islet district.*—Two operators of mines shipped 50 tons of ore, containing $55 in gold, 7,130 ounces of silver, 3,595 pounds of copper, and 27,662 pounds of lead, valued in all at $5,528, or an average of $110.56 per ton. The Morrison group of claims yielded part of the ore output, containing principally lead and silver, with a little gold and copper.

### UINTA COUNTY.

On Green River, 20 miles from Vernal, Utah, the bench gravels of the Horseshoe placer were worked. Improved methods of amalgamating the gold have brought about an increased production for this locality.

### UTAH COUNTY.

Fifteen producers reported in 1911 the mining of 60,609 tons of ore, which is 1,033 tons more than was mined by 13 operators in 1910. The total average value per ton of the ore decreased from $31.22 in 1910 to $17.70 in 1911, and the gold and silver value from $16.97 to $10.40 per ton. The larger part of the tonnage was mined in the Tintic district, which is mentioned under Juab County.

*Alpine district.*—A small lot of ore, containing principally silver and a little lead and gold, was shipped from the Lucky Chance property.

*American Fork district.*—There were 6 mining properties producing ore of shipping grade which aggregated 494 tons, containing $1,634 in gold, 9,441 ounces of silver, 4,092 pounds of copper, and 386,544 pounds of lead, valued in all at $24,543, or an average of $49.68 per ton. The principal shipments were made from the Blue Rock and Live Yankee mines. The Blue Rock property is opened by an adit 1,000 feet long, in which the vein was opened up for about 200 feet, and produced lead sulphide ore containing silver with a little copper and gold. The Live Yankee produced similar ore, taken from large bowlders of ore uncovered from the surface of the mine. Lead carbonates were shipped from the Miller group by lessees.

*Santaquin district.*—The Crown Jewel group is developed by a tunnel 1,200 feet long, with several crosscuts and branches. Shipments of mixed carbonate and sulphide ores were made and carried only lead and silver.

### WASATCH COUNTY.

The producing mines in this county are situated in the Park City district, which covers a large part of the area of Summit County, and the production is mentioned under that chapter. The total output of the county aggregated 59,483 tons of ore, which was 3,375 tons greater than in 1910 and was valued for the gold, silver, copper, lead, and zinc at $870,812, or an average of $14.64 per ton, of which the gold and silver value was $5.23. The bulk of the ores produced, or 51,875 tons, was concentrated, yielding 15,020 tons of lead and zinc concentrates, valued at $544,764, or an average of $36.27 per ton. The crude ores shipped amounted to 7,608 tons and contained only gold, silver, copper, and lead. This was valued at $326,047, or an average of $42.86 per ton. The Daly-Judge was the principal producer and is mentioned under the chapter for the Park City region, in Summit County. Lead-silver ore, containing gold and copper, was shipped from the Revelator claim, which is opened by an adit 200 feet long.

### WASHINGTON COUNTY.

*Harrisburg and Tutsagubet district.*—This old silver region, which at the time of its discovery was the subject of widespread attention in the mining world because of the unusual occurence of the high silver values in blanket veins in sandstone, is again being exploited. The old Stormont mine has an 800-foot incline, with a vertical depth of 450 feet, and is under development. At one time it had a busy little mill on the Rio Virgin. Some miners have worked the mines on a small scale the last few years, but little systematic mining has been done. The Brundage Co. has a 50-ton mill on Quayle Creek, near the old camp about 18 miles southwest of St. George. The Dixie and Paymaster mines, both formerly producers of copper ore, are situated in the region.

## WASHINGTON

By C. N. Gerry.

### PRODUCTION.

The value of the output of gold, silver, copper, lead, and zinc in Washington, for the year 1911, was $1,056,017, or an increase of $87,768. There was a decrease in lead production, but increases in all other metals. A few initial shipments of zinc ore were made during the year. There were 24 producing placers in 1911, against 21 in 1910, but the producing deep mines decreased from 55 in 1910 to 36 in 1911.

*Mine production of gold, silver, and associated metals in Washington in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (—). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 38,126.51 | $788,145 | 41,006.37 | $847,677 | +2,879.86 | +$59,532 |
| Silver.....do.... | 205,345 | 110,886 | 243,781 | 129,204 | + 38,436 | + 18,318 |
| Copper.....pounds.. | 86,918 | 11,038 | 318,207 | 39,776 | + 231,289 | + 28,738 |
| Lead.....do.... | 1,322,287 | 58,180 | 848,584 | 38,186 | — 473,703 | — 19,994 |
| Zinc.....do.... | ..... | ..... | 20,590 | 1,174 | + 20,590 | + 1,174 |
| Total..... | ..... | 968,249 | ..... | 1,056,017 | ..... | + 87,768 |

Contrasts in the output of recent years are plainly shown in the following table:

*Output of ore sold or treated in Washington in 1904–1911, and content of gold, silver, and associated metals.*

| Years. | Tonnage. | Gold. | Silver. | Copper. | Lead. | Zinc. | Total value. |
|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| 1904..... | 59,310 | 15,212.13 | 157,598 | 350,047 | 1,760,309 | ..... | $518,019 |
| 1905..... | 46,650 | 19,595.63 | 125,376 | 108,709 | 605,043 | ..... | 526,200 |
| 1906..... | 27,133 | 10,722.22 | 45,878 | 235,030 | 926,100 | ..... | 350,533 |
| 1907..... | 44,413 | 12,532.70 | 55,359 | 297,812 | 820,035 | ..... | 398,635 |
| 1908..... | 37,633 | 11,718.07 | 88,823 | 312,030 | 1,150,429 | ..... | 378,816 |
| 1909..... | 36,308 | 17,514.22 | 79,488 | 255,134 | 288,700 | ..... | 448,990 |
| 1910..... | 59,209 | 38,126.51 | 205,345 | 86,918 | 1,322,287 | ..... | 968,249 |
| 1911..... | 82,305 | 41,006.37 | 243,781 | 318,207 | 848,584 | 20,590 | 1,056,017 |

### ORE PRODUCTION IN 1911.

There were 82,305 tons of ore shipped or treated in 1911, an increase of 23,096 tons. The value per ton of this ore in all metals was $12.78, a decline from $16.29 in 1910. In gold and silver, the ore had a value of $15.12 in 1910 and of only $11.82 in 1911. The greater part of the ore, nearly 93 per cent, was dry or siliceous ore, averaging 0.53 ounce of gold and 2.66 ounces of silver; 5 per cent was copper ore, containing 0.03 ounce of gold, 7.31 ounces of silver, and 29 per cent copper; and 2 per cent was lead ore, containing 4.51 ounces of silver and 25 per cent lead. A few trial shipments of zinc ore were made. Ferry County supplied over two-thirds of the total and Stevens County nearly one-third. Most of the ore was an iron sulphide containing gold and silver, used at both copper and lead plants. Included under

the heading of siliceous ore, aggregating 76,239 tons, are 7,094 tons of sulphide iron ore, 29 tons of ore with a siliceous gangue containing silver only, and 69,116 tons of ore containing both gold and silver. Of the last tonnage 10,833 was oxidized and 58,233 was sulphide ore having a siliceous gangue.

*Output of ore and production of metals in Washington in 1911, by kinds of ore.*

| Source of production. | Number of producers. | Tonnage. | Gold. | Silver. | Copper. | Lead. | Zinc. |
|---|---|---|---|---|---|---|---|
| | | | *Fine ozs.* | *Fine ozs.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Placers | 24 | ..... | 193.45 | 54 | ..... | ..... | ..... |
| Siliceous ore | 23 | 76,239 | 40,684.39 | 202,768 | 61,667 | ..... | ..... |
| Copper ore | 8 | 4,362 | 117.53 | 31,899 | 253,333 | ..... | ..... |
| Lead ore | 4 | 1,653 | 2.00 | 7,458 | 2,796 | 836,602 | ..... |
| Lead-zinc ore | 1 | 51 | 9.00 | 1,602 | 411 | 11,982 | 20,590 |
| Total | 60 | 82,305 | 41,006.37 | 243,781 | 318,207 | 848,784 | 20,590 |

*Subdivision of tonnage, by kinds of ore sold or treated from Washington in 1911, by counties, in short tons.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|
| Chelan | 760 | ..... | ..... | ..... | 760 |
| Ferry | 51,429 | 3,106 | ..... | ..... | 54,535 |
| King | 481 | ..... | ..... | ..... | 481 |
| Kittitas | 23 | ..... | ..... | ..... | 23 |
| Lewis | ..... | 19 | ..... | ..... | 19 |
| Okanogan | 289 | ..... | ..... | ..... | 289 |
| Pend Oreille | ..... | ..... | ..... | 51 | 51 |
| Skagit | ..... | 1 | ..... | ..... | 1 |
| Stevens | 23,257 | 1,236 | 1,653 | ..... | 26,146 |
| Total | [a] 76,239 | 4,362 | 1,653 | 51 | 82,305 |
| Average value per ton in gold and silver | $12.44 | $4.43 | $2.42 | $20.29 | $11.82 |

[a] Includes 76,210 tons of gold and gold-silver ores and 29 tons of silver ores.

According to the following summary of milling plants in the State in 1911 nearly two-thirds of the total, or 21 mills, were idle, 4 were in course of construction, and 8 were in operation during part or all of the year. Twelve plants were equipped for amalgamation, 7 for cyanidation, and 22 for concentration. The list, complete as far as reported, is as follows:

## REDUCTION MILLS.

*List of reduction mills in Washington in 1911, by counties.*

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| CHELAN COUNTY. | | | | *Short tons.* |
| Aurelia Crown [a] | Chelan Lake | Concentration | Crushers, jigs, and table. | 10 |
| Cook [a] | do | Amalgamation | 2 stamps | 10 |
| La Rica [a] | Blewett | Amalgamation, concentration, cyanidation. | 20 stamps, 4 concentration tables, 4 tanks. | 80 |
| Golden Eagle [b] | do | Amalgamation | 6 stamps | 30 |
| Wenatchee [b] | Entiat | do | 2-stamp Hammond | 4 |

[a] Idle in 1911. [b] Active in 1911.

*List of reduction mills in Washington in 1911, by counties*—Continued.

| Name. | District. | Process. | Equipment. | Approximate maximum capacity per day. |
|---|---|---|---|---|
| FERRY COUNTY. | | | | *Short tons.* |
| Rathfon Reduction Co.[a] | Republic | Cyanidation | 5 tanks | 50 |
| North Washington [b] | do | do | Tanks | [c] 125 |
| San Poil [b] | do | do | do | 125 |
| KING COUNTY. | | | | |
| Seattle Cascade [b] | Miller River | Concentration | Merrill mill | 300 |
| KITTITAS COUNTY. | | | | |
| Maude O [d] | Cle Elum | Amalgamation | 4 stamps | 16 |
| Cougar [b] | Swauk | Amalgamation, concentration. | 10 stamps, crusher, vanner, and table. | 40 |
| Fanny Edel [d] | do | do | Crusher, roller mill, and table. | 40 |
| Wall Street [d] | do | Amalgamation | 2 stamps | 10 |
| OKANOGAN COUNTY. | | | | |
| Molson [d] | Myers Creek | Amalgamation, concentration. | 6 Nissen stamps, crusher, tables. | 25 |
| Apex [d] | do | Concentration | Rolls and vanners | 10 |
| Night Hawk [d] | Palmer Mountain | do | 20 stamps | 80 |
| Phoenix [d] | do | do | Crusher | 10 |
| Hidden Treasure [d] | Squaw Creek | do | Tables | 30 |
| Bodie [a] | Wauconda | Amalgamation, cyanidation. | 10 stamps and tanks | 30 |
| SNOHOMISH COUNTY. | | | | |
| Wayside [d] | Granite Falls | Concentration | | 100 |
| Bunker Hill [d] | Index | do | Crusher, rolls, jigs, Wilfleys. | 100 |
| STEVENS COUNTY. | | | | |
| Germania [a] | Cedar Canyon | Concentration | For tungsten ore | 50 |
| Deer Park [a] | Chewelah | do | For tungsten ore, crusher, rolls, jigs. | 20 |
| United Copper [a] | do | do | Tables | 75 |
| Napoleon [a] | Marcus | Amalgamation, cyanidation. | 10 stamps, crusher, tube mill, plates, tanks. | 100 |
| Aladdin [d] | Northport | Concentration | Tables | 50 |
| Forest [d] | Orient | Amalgamation, cyanidation. | 10 stamps and tanks | 40 |
| Kettle River [d] | do | Concentration | Crusher, rolls, tables | 75 |
| Skookum [d] | Springdale | do | Rolls, Wilfleys | 75 |
| WHATCOM COUNTY. | | | | |
| Great Excelsior [d] | Mount Baker | Concentration | 20 stamps, tables, crusher. | 60 |
| Mount Baker [d] | do | do | 15 stamps | 50 |
| Seattle-St. Louis [d] | Slate Creek | do | Stamps, tables | 20 |
| YAKIMA COUNTY. | | | | |
| Elizabeth [e] | North Yakima | Concentration | 10 stamps | 40 |

[a] Active in 1911.
[b] Under construction in 1911.
[c] One unit.
[d] Idle in 1911.
[e] Delivered, but not erected.

Nearly 23 per cent of the total tonnage was ore and tailings treated in gold and silver mills. This quantity, 18,844 tons, contained $72,028 in gold and 2,902 ounces of silver, or an average of $3.90 per ton for both metals. In the following table a separation has been made to show the bullion derived from ore amalgamated and that from ore cyanided. This was almost evenly divided, but the majority of mills used amalgamation. Approximately 526 pounds of mercury were consumed on ores amalgamated and 9,700 pounds of potassium cyanide on ores cyanided.

*Tonnage of ore to gold and silver mills, by processes, with quantity of gold and silver contained in bullion produced in Washington in 1911, by counties.*

| County. | Quantity. | Bullion recovered from ore by— | | | | Total value. |
|---|---|---|---|---|---|---|
| | | Amalgamation. | | Cyanidation. | | |
| | | Gold. | Silver. | Gold. | Silver. | |
| | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Fine ounces.* | *Fine ounces.* | |
| Chelan | 760 | 1,042.39 | 477 | | | $21,801 |
| Ferry | | | | [a]1,321.73 | [a] 2,205 | 28,491 |
| Kittitas | 23 | 36.57 | 17 | | | 765 |
| Okanogan | 230 | 120.32 | 120 | | | 2,550 |
| Stevens | 10,833 | 783.36 | 67 | 180.00 | 16 | 19,959 |
| Total | 11,846 | 1,982.64 | 681 | 1,501.73 | 2,221 | 73,566 |

[a] Produced from 6,998 tons of old tailings.

Concentration was not used widely in 1911, but there will probably be a larger tonnage so treated in 1912.

*Mine production of gold, silver, and copper from Washington concentrates in 1911, by counties.*

| County. | Ore to concentrating mills. | Concentrates produced. | | | | Total value of concentrates. |
|---|---|---|---|---|---|---|
| | | Quantity. | Gold. | Silver. | Copper. | |
| | *Short tons.* | *Short tons.* | *Fine ounces.* | *Fine ounces.* | *Pounds.* | |
| Stevens | 108 | 36 | 0.72 | 1,467 | 7,937 | $1,784 |
| Subdivision by kinds of concentrates: | | | | | | |
| Copper | | 36 | .72 | 1,467 | 7,937 | 1,784 |

The greater part of the ore, or 63,353 tons, was shipped to various smelting plants. Only one custom plant at Tacoma was active in the State in 1911, a large portion of the ore being shipped to Canadian plants. This first-class ore had an average value of $15.42 per ton, and over 90 per cent of it was siliceous. Lead ore shipped had a value per ton of $25.40; copper ore, $11.57; siliceous ore, $15.38; and lead-zinc ore, $54.88 per ton.

*Mine production of gold, silver, copper, lead, and zinc from Washington crude ore shipped to smelters in 1911, by counties.*

| County. | Crude ore to smelter. | | | | | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Gold. | Silver. | Copper. | Lead. | Zinc. | |
| | *Short tons.* | *Fine ozs.* | *Fine ozs.* | *Pounds.* | *Pounds.* | *Pounds.* | |
| Ferry | 47,537 | 36,337.04 | 183,034 | 161,158 | | | $868,307 |
| King | 481 | 543.98 | 3,499 | | | | 13,099 |
| Lewis | 19 | .19 | 28 | 3,425 | | | 447 |
| Okanogan | 59 | 92.00 | 12,081 | | | | 8,305 |
| Pend Oreille | 51 | 9.00 | 1,602 | 411 | 11,982 | 20,590 | 2,799 |
| Skagit | 1 | | | 101 | | | 13 |
| Stevens | 15,205 | 345.62 | 39,114 | 145,175 | 836,602 | | 83,670 |
| Total | 63,353 | 37,327.83 | 239,358 | 310,270 | 848,584 | 20,590 | 976,640 |
| Subdivision by kinds of ore: | | | | | | | |
| Dry or siliceous | 57,395 | 37,200.03 | 199,866 | 61,667 | | | 882,631 |
| Copper | 4,254 | 116.80 | 30,432 | 245,396 | | | 49,219 |
| Lead | 1,653 | 2.00 | 7,458 | 2,796 | 836,602 | | 41,991 |
| Lead-zinc | 51 | 9.00 | 1,602 | 411 | 11,982 | 20,590 | 2,799 |

## GOLD.

The production of gold was 41,006.37 fine ounces, valued at $847,677, in 1911, against 38,126.51 ounces, valued at $788,145, in 1910, an increase of 2,879.86 ounces in quantity and of $59,532 in value. This was a slight increase compared with the output of 1910, but a far greater one compared with that of previous years. This output and increase are to be credited largely to Ferry County and slightly to Chelan County. Placers produced $3,999 in gold. Gold recovered from bullion was valued at $72,028, and gold in crude ore shipped was valued at $771,636. Over 99 per cent of the gold output came from siliceous ore.

*Source of gold production in Washington, by kinds of ore, in 1911, by counties, in fine ounces.*

| County. | Placers. | Dry or siliceous ore. | Copper ore. | Lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|
| Chelan | 14.41 | 1,042.39 | | | | 1,056.80 |
| Ferry | 2.42 | 37,561.77 | 97.00 | | | 37,661.19 |
| King | | 543.98 | | | | 543.98 |
| Kittitas | 98.93 | 36.57 | | | | 135.50 |
| Lewis | | | .19 | | | .19 |
| Okanogan | 16.16 | 212.32 | | | | 228.48 |
| Pend Oreille | 21.62 | | | | 9.00 | 30.62 |
| Snohomish | 20.95 | | | | | 20.95 |
| Stevens | | 1,287.36 | 20.34 | 2.00 | | 1,309.70 |
| Whatcom | 9.14 | | | | | 9.14 |
| Whitman | 9.82 | | | | | 9.82 |
| Total | 193.45 | [a] 40,684.39 | 117.53 | 2.00 | 9.00 | 41,006.37 |

[a] All from gold and gold-silver ores. No gold produced from silver ores.

## SILVER

From a production of 205,345 ounces, valued at $110,886, in 1910, the silver output increased to 243,781 ounces, valued at $129,204, in 1911, an increase of 38,436 ounces in quantity and of $18,318 in value. Ferry County produced most of the silver, but increases were made principally in Okanogan and Stevens counties. Crude ore shipped supplied 239,358 ounces, concentrates 1,467 ounces, and mill bullion only 2,902 ounces. Copper ore contained about 13 per cent of the silver, lead ore 3 per cent, and siliceous ore 83 per cent.

*Source of silver production in Washington, by kinds of ore, in 1911, by counties, in fine ounces.*

| County. | Placers. | Dry or siliceous ore. | Copper ore. | Lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|---|
| Chelan | 3 | 477 | | | | 480 |
| Ferry | | 184,756 | 483 | | | 185,239 |
| King | | 3,499 | | | | 3,499 |
| Kittitas | 38 | 17 | | | | 55 |
| Lewis | | | 28 | | | 28 |
| Okanogan | 3 | 12,201 | | | | 12,204 |
| Pend Oreille | 3 | | | | 1,602 | 1,605 |
| Skagit | | | | | | |
| Snohomish | 5 | | | | | 5 |
| Stevens | | 1,818 | 31,388 | 7,458 | | 40,664 |
| Whatcom | 1 | | | | | 1 |
| Whitman | 1 | | | | | 1 |
| Total | 54 | [a] 202,768 | 31,899 | 7,458 | 1,602 | 243,781 |

[a] Includes 200,253 ounces from gold and gold-silver ores, and 2,515 ounces from silver ores.

### COPPER.

The copper output increased from 86,918 pounds, valued at $11,038, in 1910, to 318,207 pounds, valued at $39,776, in 1911, an increase of 231,289 pounds in quantity and of $28,738 in value. This output, which is larger than any since 1904, was almost equally divided between Ferry and Stevens counties. Nearly 20 per cent was derived from siliceous ore, less than 1 per cent from lead ore, and nearly 80 per cent from copper ore.

*Source of copper production in Washington, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|
| Ferry | 21,677 | 139,481 | ..... | ..... | 161,158 |
| Lewis | ..... | 3,425 | ..... | ..... | 3,425 |
| Pend Oreille | ..... | ..... | ..... | 411 | 411 |
| Skagit | ..... | 101 | ..... | ..... | 101 |
| Stevens | 39,990 | 110,326 | 2,796 | ..... | 153,112 |
| Total | [a] 61,667 | 253,333 | 2,796 | 411 | 318,207 |

[a] All from gold and gold-silver ores; none from silver ores.

### LEAD.

The output of lead decreased from 1,322,287 pounds, valued at $58,180, in 1910, to 848,584 pounds, valued at $38,186, in 1911, a decrease of 473,703 pounds in quantity and of $19,994 in value. Nearly all the product came from lead ore in Stevens County. A small quantity came from the eastern part of Stevens County, now named Pend Oreille County.

*Source of lead production in Washington, by kinds of ore, in 1911, by counties, in dry pounds.*

| County. | Dry or siliceous ore. | Copper ore. | Lead ore. | Lead-zinc ore. | Total. |
|---|---|---|---|---|---|
| Pend Oreille | ..... | ..... | ..... | 11,982 | 11,982 |
| Stevens | ..... | ..... | 836,602 | ..... | 836,602 |
| Total | ..... | ..... | 836,602 | 11,982 | 848,584 |

### ZINC.

Zinc was marketed for the first time in the State from zinc-lead ore mined at Metaline, in Pend Oreille County.

## MINING INDUSTRY IN WASHINGTON IN 1911.

Although there was a greater tonnage of ore sold and a slightly increased production of the principal metals, the value of the shipping ore in gold and silver was considerably decreased. This was especially true of Republic district, the principal one of the State, and accounts for the activity in the building of cyanide mills in that locality. One plant was operated on old tailings, another large one

was being constructed, and the construction of a third was begun at the end of the year.

*Mine production of gold, silver, copper, lead, and zinc in Washington in 1911, by counties.*

| County. | Tonnage. | Gold. | | Silver. | |
|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value |
| | *Short tons.* | *Fine ozs.* | | *Fine ozs.* | |
| Chelan | 760 | 1,056.80 | $21,846 | 480 | $254 |
| Ferry | 54,535 | 37,661.19 | 778,526 | 185,239 | 98,177 |
| King | 481 | 543.98 | 11,245 | 3,499 | 1,854 |
| Kittitas | 23 | 135.50 | 2,801 | 55 | 29 |
| Lewis | 19 | .19 | 4 | 28 | 15 |
| Okanogan | 289 | 228.48 | 4,723 | 12,204 | 6,468 |
| Pend Oreille | 51 | 30.62 | 633 | 1,605 | 851 |
| Skagit | 1 | ..... | ..... | ..... | ..... |
| Snohomish | ..... | 20.95 | 433 | 5 | 2 |
| Stevens | 26,146 | 1,309.70 | 27,074 | 40,664 | 21,552 |
| Whatcom | ..... | 9.14 | 189 | 1 | 1 |
| Whitman | ..... | 9.82 | 203 | 1 | 1 |
| Total | 82,305 | 41,006.37 | 847,677 | 243,781 | 129,204 |

| County. | Copper. | | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | *Pounds.* | | |
| Chelan | ..... | ..... | ..... | ..... | ..... | ..... | $22,100 |
| Ferry | 161,158 | $20,145 | ..... | ..... | ..... | ..... | 896,848 |
| King | ..... | ..... | ..... | ..... | ..... | ..... | 13,099 |
| Kittitas | ..... | ..... | ..... | ..... | ..... | ..... | 2,830 |
| Lewis | 3,425 | 428 | ..... | ..... | ..... | ..... | 447 |
| Okanogan | ..... | ..... | ..... | ..... | ..... | ..... | 11,191 |
| Pend Oreille | 411 | 51 | 11,982 | $539 | 20,590 | $1,174 | 3,248 |
| Skagit | 101 | 13 | ..... | ..... | ..... | ..... | 13 |
| Snohomish | ..... | ..... | ..... | ..... | ..... | ..... | 435 |
| Stevens | 153,112 | 19,139 | 836,602 | 37,647 | ..... | ..... | 105,412 |
| Whatcom | ..... | ..... | ..... | ..... | ..... | ..... | 190 |
| Whitman | ..... | ..... | ..... | ..... | ..... | ..... | 204 |
| Total | 318,207 | 39,776 | 848,584 | 38,186 | 20,590 | 1,174 | 1,056,017 |

*Tonnage of ore sold or treated, number of deep mines producing, and value of ores in Washington in 1910 and 1911, by counties.*

| County. | Ore sold or treated. | | Number of deep mines producing. | | Average total value per ton.[a] | | Average value per ton in gold and silver.[a] | |
|---|---|---|---|---|---|---|---|---|
| | 1911 | Increase (+) or decrease (−). | 1910 | 1911 | 1910 | 1911 | 1910 | 1911 |
| | *Short tons.* | | | | | | | |
| Chelan | 760 | + 586 | 7 | 3 | $39.66 | $28.68 | $39.66 | $28.68 |
| Ferry | 54,535 | +16,664 | 19 | 13 | 21.50 | 16.44 | 21.50 | 16.07 |
| King | 481 | − 216 | 1 | 1 | 30.30 | 27.23 | 30.30 | 27.23 |
| Kittitas | 23 | − 1 | 4 | 2 | 18.83 | 33.26 | 18.83 | 33.26 |
| Lewis | 19 | + 19 | ..... | 2 | ..... | 23.53 | ..... | 1.00 |
| Okanogan | 289 | − 1,638 | 9 | 3 | 7.69 | 37.56 | 7.68 | 37.56 |
| Pend Oreille | 51 | + 51 | ..... | 1 | ..... | 54.88 | ..... | 20.29 |
| Pierce | ..... | − 20 | 1 | ..... | 12.05 | ..... | .85 | ..... |
| Skagit | 1 | ..... | 1 | 1 | 5.00 | 13.00 | 3.00 | ..... |
| Snohomish | ..... | − 19 | 1 | ..... | 2.37 | ..... | 2.37 | ..... |
| Stevens | 26,146 | + 7,673 | 12 | 10 | 5.75 | 4.03 | 2.02 | 1.86 |
| Total | 82,305 | +23,096 | 55 | 36 | 16.29 | 12.78 | 15.12 | 11.82 |

[a] Value per ton, placer product excluded.

Of the 24 placers, 5 were operated by drifting and 19 by the hydraulic or sluicing methods. The deep mines were classified as follows: gold-silver, 18; gold-silver-copper, 10; silver, 3; silver-lead, 2; lead, 1; gold-silver-copper-lead, 1; and gold-silver-copper-lead-zinc, 1.

## REVIEW BY COUNTIES.

### CHELAN COUNTY.

The output of gold and silver from Chelan County from 3 deep mines and 3 placers increased to three times the production of 1910, or $21,846 in gold and 480 ounces of silver. There were 760 tons of ore treated, all of which went to amalgamation mills and had an average bullion value of $28.68 per ton.

*Blewett district.*[1]—From small placers and mill bullion $3,095 in gold and 41 ounces of silver were secured. The ore averaged $10.41 per ton.

*Entiat district.*—The Wenatchee Gold Mining Co. operated the Rex mine and shipped bullion from a small Hammond mill. The ore is oxidized to a depth of 90 feet.

### FERRY COUNTY.

*Mine production of gold, silver, and associated metals in Ferry County, Wash., in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 34,578.84 | $714,808 | 37,661.19 | $778,526 | +3,082.35 | +$63,718 |
| Silver.....do.... | 185,357 | 100,092 | 185,239 | 98,177 | − 118 | − 1,915 |
| Copper.....pounds.. | 61 | 8 | 161,158 | 20,145 | + 161,097 | + 20,137 |
| Lead.....do.... | 128 | 5 | ..... | ..... | − 128 | − 5 |
| Total..... | ..... | 814,913 | ..... | 896,848 | ..... | + 81,935 |

There was an increase in output of gold and copper in this county, but practically no change in silver production. Nearly 85 per cent of the value of the State output was derived from ore from Ferry County. The tonnage increased from 37,874 tons in 1910 to 54,535 tons in 1911, and had an average value of $16.44 per ton and a value of $16.07 for gold and silver alone. The decrease in value of $5.06 per ton was due partly to the treatment of old tailings, but principally to the shipment of a lower grade of ore. The greater part of the ore, 47,537 tons, was shipped to smelters and was valued at $18.27 per ton.

*Belcher district.*—The Belcher property, northeast of Republic, was, as formerly, the source of a sulphide iron ore which is used as a flux and contains gold, silver, and some copper.

*Danville district.*—Copper ore was shipped from the Shonee mine and a group including the Lone Star and the Washington mines. On the latter property a 5½-mile aerial tram was completed in 1911. Most of the ore was chalcopyrite with gold and silver.

[1] For description of the district see Weaver, C. E., Geology and ore deposits of the Blewett mining district; Bull. Washington Geol. Survey, Nov. 6, 1911.

*Enterprise district.*—Small trial shipments of silver ore were made from the Ivanhoe and Silver Leaf mines.

*Republic district.*[1]—From 8 deep mines 44,322 tons of ore were produced, containing $772,874 in gold and 181,574 ounces of silver. The ore is a highly siliceous iron sulphide, in veins. The above tonnage includes 6,998 tons of old tailings re-treated. The ore, shipped to Tacoma, Butte, and Canadian plants, had an average value of $22.52 per ton. Mining, smelting, and freight are said to cost about $12 per ton. The Republic Mines Corporation, operating the Surprise, Lone Pine, and Pearl mines, was again the largest producer of the State. Shipments were made at the rate of about 2 cars per day, and 3,000 feet of development was done. Ore shipped contained about 1 ounce of gold and 4 ounces of silver per ton. Considerable low-grade ore was stored for treatment in the cyanide plant of the North Washington Power & Reduction Co. The first unit of 125 tons of this plant was erected during the year. In December arrangements were made for better transportation of ore from intermediate levels of the Surprise mine. The Knob Hill, the next largest producer, was operated 11 months and produced 204 cars of ore. According to a printed report, 6,565 tons of ore were shipped having a net value of $135,275. Many car lots assayed 3 ounces gold and 7 ounces silver per ton. Other producers were the Insurgent, Imperator Quilp, San Poil, Hope, and Ben Hur. The Rathfon Reduction Co. cyanided old mill tailings of the Republic mine in a 50-ton plant. The San Poil Consolidated Co. took over the San Poil, North San Poil, Trade Dollar, etc., shipped considerable ore, and nearly completed a 125-ton cyanide plant. Dividends of $12,500 and $30,000, respectively, were paid on the Insurgent and the Quilp properties. About 7,065 tons of ore, containing 5,762 ounces of gold and 41,630 ounces of silver, have been shipped from the Insurgent, but this total includes several hundred tons shipped in 1910.

KING COUNTY.

*Miller Creek district.*—Ore containing more than an ounce of gold and about 7 ounces of silver was shipped from the Miller district near Berlin. This was a sulphide ore which occurs in granite and is said to contain much arsenic.

KITTITAS COUNTY.

*Swauk district.*—The Swauk district produced 23 tons of ore, $2,801 in gold and 55 ounces of silver, from 2 deep mines and 9 placers, a slight decrease from the output of 1910. A 10-stamp mill was built at the First of August mine, near Liberty. The ore averaged $33.26 per ton.

LEWIS COUNTY.

*Rainier National Park district.*—Trial shipments of copper ore were made from property in the vicinity of Ashford. The ore is said to contain molybdenum.

[1] For recent references see Eng. and Min. Jour., July 1, 1911, p. 13; Bull. 1, Washington Geol. Survey No. 1, 1910; Min. and Sc. Press, Aug. 24, 1912, p. 235.

### OKANOGAN COUNTY.

From 3 deep mines and 3 placers Okanogan County produced 289 tons of ore, $4,723 in gold, 12,204 ounces of silver, valued in all at $11,191. This was a decrease in gold and an increase in silver output.

*Myers Creek district.*—Gold ore was shipped from the Gold Ax mine, near Chesaw. This district and that of Palmer Mountain or Oroville-Nighthawk are described by State reports.[1]

*Nespelem district.*—A small amount of rich silver ore was marketed from the Apache property.

*Wauconda district.*—The Bodie mine was the source of some bullion recovered by amalgamation.

### PEND OREILLE COUNTY.

In the early part of 1911 Pend Oreille County was formed from the eastern half of Stevens County.

*Metaline district.*—Placer gold was mined by sluicing on Sullivan Creek, and some ore containing gold, silver, copper, lead, and zinc was shipped from the Oriole mine. This is the first record of zinc being marketed. The ore minerals are chiefly galena and sphalerite with some pyrite and chalcopyrite occurring in veins in dolomite.[2]

### SKAGIT COUNTY.

*Jackman Creek district.*—A small test was made on chalcopyrite in limestone near Van Horn.

### SNOHOMISH COUNTY.

*Sultan district.*—Gold from small placers was valued at $435.

### STEVENS COUNTY.

*Mine production of gold, silver, and associated metals in Stevens County, Wash., in 1910 and 1911.*

| County. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 1,460.05 | $30,182 | 1,309.70 | $27,074 | − 150.35 | −$3,108 |
| Silver.....do.... | 13,281 | 7,172 | 40,664 | 21,552 | + 27,383 | +14,380 |
| Copper.....pounds.. | 85,063 | 10,803 | 153,112 | 19,139 | + 68,049 | + 8,336 |
| Lead.....do.... | 1,321,871 | 58,162 | 836,602 | 37,647 | −485,269 | −20,515 |
| Total..... | ..... | 106,319 | ..... | 105,412 | ..... | − 907 |

In regard to output, Stevens County was the only one of importance, except Ferry County. As to value, the output remained much the same as in 1910. Decreases in lead and gold production were offset to a great extent by increases in output of silver and copper. In 1911,

[1] Umpleby, Jos. B., Geology and ore deposits of the Meyers Creek mining district; Geology and ore deposits of the Oroville-Nighthawk mining district: Bull. Washington Geol. Survey No. 5.

[2] Bancroft, H., Lead and zinc deposits in the Metaline mining district, northeastern Washington: Bull. U. S. Geol. Survey No. 470, 1911, p. 195.

26,146 tons of ore were sold or treated, an increase of 7,673 tons. The average recovered value decreased from $5.75 per ton to $4.03, due to the treatment of much low-grade ore in gold and silver mills. Of the total tonnage, 108 tons were concentrated, 15,205 tons were shipped crude, and the remainder was amalgamated or cyanided. The first-class ore was valued at $83,670, or $5.50 per ton. There were 23,257 tons of siliceous ore, 1,236 tons of copper, and 1,653 tons of lead ore.

*Bossburg district.*[1]—The Bonanza mine was productive of considerable galena which contained a small percentage of silver. The shipping point is Evans, on the Great Northern Railroad.

*Cedar Canyon district.*—Shipments consisted of a small quantity of silver ore from the Providence mine and lead ore from the Cleveland.

*Chewelah district.*—The output was 1,322 tons of ore, $462 in gold, 32,762 ounces of silver, 113,122 pounds of copper, and 77,016 pounds of lead, valued in all at $35,432, or an average of $26.80 per ton. Production came from the United Copper, Blue Star, Banshee, and Amazon mines. A new 75-ton concentration plant was erected by the United Copper Co. and operated on a sulphide copper ore.

*Kettle Falls district.*—A small quantity of oxidized ore, containing gold and silver, was shipped from the Ben Venue mine, near Meyers Falls.

*Marcus district.*—From the Napoleon mine, at Marcus, a low-grade sulphide ore was shipped to be used as a flux, and a soft oxidized ore was treated by amalgamation and cyanide in a 10-stamp plant, tube mill, and vats.

*Northport district.*—The only producing property was the Jupiter mine. A rich lead ore, containing no silver, was sent to Missouri.

### WHATCOM AND WHITMAN COUNTIES.

Only small amounts of placer gold were marketed from these counties.

## WYOMING.

By Charles W. Henderson.

### PRODUCTION.

The total value of the production of gold, silver, and copper in the State of Wyoming in the calendar year 1911 was $34,407, an increase of $2,173. The gold yield increased appreciably, but the output of copper decreased. There were 16 producing mines, of which 7 were deep and 9 were placer.

*Mine production of gold, silver, and copper in Wyoming in 1910 and 1911.*

| Metal. | 1910 | | 1911 | | Increase (+) or decrease (−). | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Gold.....fine ounces.. | 154.75 | $3,199 | 928.80 | $19,200 | + 774.05 | +$16,001 |
| Silver.....do.... | 1,478 | 798 | 725 | 384 | − 753 | − 414 |
| Copper.....pounds.. | 222,339 | 28,237 | 118,584 | 14,823 | −103,755 | − 13,414 |
| Total..... | ..... | 32,234 | ..... | 34,407 | ..... | + 2,173 |

[1] Ann. Rept. Washington Geol. Survey, vol. 1, 1902, p. 45.

The tonnage sold or treated was 3,491 short tons, as compared with 1,474 tons in 1910. The output of siliceous ore increased from 504 tons in 1910 to 1,447 tons in 1911, while that of copper ore increased from 970 tons to 2,044 tons. Deep mines yielded $12,159 in gold, 515 fine ounces of silver, and 118,584 pounds of copper. Placer gold production amounted to $7,041 in 1911, as compared with $654 in 1910.

The copper yield, usually of chief importance in this State, represented only 43 per cent of the State total in 1911, gold representing 56 per cent of the value.

The following table shows the total output of copper in Wyoming since 1881, when copper was first discovered in the State.[1]

*Production of copper in Wyoming, 1882–1911.*

| | Pounds. | | Pounds. |
|---|---|---|---|
| 1882 | 100,000 | 1898 | 233,044 |
| 1883 | 962,468 | 1899 | 3,104,827 |
| 1884 | | 1900 | 4,203,776 |
| 1885 | | 1901 | 2,698,712 |
| 1886 | | 1902 | 889,228 |
| 1887 | | 1903 | 1,023,189 |
| 1888 | 232,819 | 1904 | 3,565,629 |
| 1889 | 100,000 | 1905 | 2,530,531 |
| 1890 | | 1906 | 106,177 |
| 1891 | | 1907 | 3,026,004 |
| 1892 | | 1908 | 2,416,197 |
| 1893 | | 1909 | 433,672 |
| 1894 | | 1910 | 217,127 |
| 1895 | | 1911 | 118,584 |
| 1896 | | | |
| 1897 | | Total | 25,961,984 |

## MINING INDUSTRY IN WYOMING IN 1911.

Mining in Wyoming in 1911, as shown by the output, was in a better condition than in 1910. The revival of the Atlantic City district, Fremont County, resulted in the marketing of gold bullion from both deep and placer mines. Several carloads of copper ore from Hartville and a car of copper ore from Saratoga were shipped to smelters. Experiments at the Rambler mill, near Holmes, resulted in some copper concentrates being shipped. There were a few small lots of placer gold recovered at Holmes, Encampment, and Hurricane.

*Source of gold and silver production in Wyoming in 1910 and 1911.*

| Source. | Number of mines. | Ore. | Gold. | | Silver. | | Total value. |
|---|---|---|---|---|---|---|---|
| | | Quantity. | Quantity. | Value. | Quantity. | Value. | |
| Deep mines: | | *Short tons.* | *Fine ounces.* | | *Fine ounces.* | | |
| Siliceous ore | 3 | 1,447 | 575.76 | $11,902 | 98 | $52 | $11,954 |
| Copper ore | 4 | 2,044 | 12.43 | 257 | 417 | 221 | 478 |
| Total, 1911, deep mines | 7 | 3,491 | 588.19 | 12,159 | 515 | 273 | 12,432 |
| Deep mines, 1910 | 8 | 1,474 | 123.11 | 2,545 | 1,476 | 797 | 3,342 |
| Increase(+)or decrease(−) | −1 | +2,017 | +465.08 | +9,614 | −961 | −524 | +9,090 |
| Placer mines, 1911 | 9 | ..... | 340.61 | 7,041 | 210 | 111 | 7,152 |
| Placer mines, 1910 | 4 | ..... | 31.64 | 654 | 2 | 1 | 655 |
| Increase(+)or decrease(−) | +5 | ..... | +308.97 | +6,387 | +208 | +110 | +6,497 |
| Total, 1911, deep and placer mines | 16 | 3,491 | 928.80 | 19,200 | 725 | 384 | 19,584 |

[1] Kirchhoff, C., jr., The Copper Industry of the United States: Mineral Resources for 1881–1882, U. S. Geol. Survey, 1883, p. 229.

## REVIEW BY COUNTIES.

### ALBANY COUNTY.

The Rambler property, at Holmes, was the only important producing mine in Albany County, and the output represents several cars of copper concentrates from experiments at the new 50-ton concentration plant erected in 1910. For one car of concentrates to Baltimore, Md., payment was received for platinum and palladium, thus marking the beginning of production of these metals from ore as distinguished from placers.

A 1-stamp mill and concentrating table was installed at the mill on the Fram property, near Centennial. A small lot of gold-bearing copper ore was shipped from the Topeka mine, near Centennial.

### CARBON COUNTY.

In the Elk Mountain district, near Arlington, in Carbon County, a car of copper ore was shipped from the Elkhorn mine. A few ounces of placer gold were recovered from the Purgatory Gulch placer, near Encampment.

Assessment and development work was done on other properties in the county.

The mines and smelter of the Penn-Wyoming Co. were idle.

### CONVERSE COUNTY.

Surface indications, as reported, show a body of copper sulphide ore at Saul's Camp, near Esterbrook, in Converse County.

### CROOK COUNTY.

A small output of placer gold was made in the Hurricane district, northwest of Tinton, S. Dak. Development work was done on the lode mines of the Roenna Mining Co. and on the Ticknor claims. The latter property is equipped with a 20-stamp mill.

The Warren Peak Mines Co., in the Bear Lodge district,[1] continued development by adits and started the erection of a 5-stamp mill. Several other properties in the district were prospected or developed.

### FREMONT COUNTY.

From 3 deep mines and 5 placers in the Atlantic City district bullion valued at $18,672 in gold and $161 in silver was shipped in 1911. The total value of the output of the county in 1910 was $1,786.

*Atlantic City (South Pass) district.*—This was the chief precious metal district in Wyoming in 1911. The Beck Mining Co. operated its Duncan mine continuously during the year and erected a 4-stamp amalgamation mill which was operated steadily from September. The mine is opened by a vertical shaft 250 feet deep and by 720 feet of drifts. A small quantity of bullion from the Mary Ellen mine was marketed. This property is opened by a shaft 238 feet deep and by 600 feet of drifts. The milling plant consists of a 5-foot Huntington mill and amalgamation plates.

[1] Darton, N. H., Sundance folio (No. 127), Geol. Atlas U. S., U. S. Geol. Survey, 1905.

The machinery at the Duncan mill was started September 5, 1911, and up to November 1 had crushed 1,100 tons of ore, working 12 hours a day. The ore, crushed to 40 mesh, is treated by amalgamation only, the tailings being stored for future treatment. Up to November 1 the production amounted to $8,451, the ore averaging about $14 per ton, an extraction of nearly 60 per cent being made.[1]

Development work only was done by the Federal Gold Mining Co. on its property, formerly the Carissa mine. This mine is opened by 400-foot vertical shaft and by 4,000 feet of drifts and crosscuts. A 10-stamp plate amalgamation mill, with Frue vanners, is on the property. Assessment work was done by the Snow Bird Co. There is an old 10-stamp amalgamation mill on this property. An appreciable quantity of placer gold was recovered from various sluicing operations during the year. The X. L. Gold Dredging Co. completed its hydraulic plant, which, it is reported, will handle 700 yards daily.

Prof. W. C. Knight, of the University of Wyoming, has reported on the geology of the district.[2]

*Copper Mountain district.*—A little development work was done in this district in 1911. The Williams-Luman property was unwatered. The Gold Nugget Co. reports a 25-ton amalgamation mill on the property.

*Dredges on Bighorn River and tributaries.*—The Shoshoni Gold Dredging Co. at the end of the year had erected its Marion dredge, of 61 buckets, on Bighorn River, near Shoshone, and the transmission line for electric power from the Boysen power plant had been strung to the dredge. The Fremont Dredging Co. has in prospect the reconstruction of its Clark portable dredge, which was placed in Big Wind River near Riverton, in 1910.

### JOHNSON COUNTY.

Development work was done on several properties in the Bull Camp district, Johnson County, southwest of Buffalo. The 5-stamp amalgamation mill on the La Porte group was used for experimental work.

### LARAMIE COUNTY.

Copper ore was shipped from the Hynds mine, near Hartville, Laramie County. In the Rawhide Buttes district, 12 miles south of Lusk, development work was done at the Copper Belt, Copper Bottom, and Grim Hope mines.

### PARK COUNTY.

Nothing but development work was done in the Sunlight and Wood River districts, Park County.

### SHERIDAN COUNTY.

Development work was reported from the Black Mountain and Mohawk districts, Sheridan County.

### UINTA COUNTY.

There were no mining operations in Uinta County in 1911.

---

[1] Jamison, C. E., The gold mines south of Lander, Wyoming: Min. and Eng. World, No. 2, Feb. 24, 1912, p. 468, being abstract from Bull. Wyo. Geol. Survey.

[2] Swarthout, Capt. A. H., Mining in Wyoming: Min. Science, Nov. 16, 1911, p. 465.

# SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES IN 1911.

(MINE PRODUCTION.)

By B. S. Butler and J. P. Dunlop.

## INTRODUCTION.

By J. P. Dunlop.

The following is an account of the production of silver, copper, lead, and zinc in 1911 by the mines of the Central States, including Arkansas, Iowa, Kansas, Kentucky, Michigan, Missouri, Oklahoma, and Wisconsin. The territory thus embraced lies in the great interior valley province of the United States, which extends from the Appalachian system to the Rocky Mountain front, excluding the Black Hills. Most of the mines are developed in the Paleozoic sedimentary rocks of this province, but the copper range of northern Michigan comprises lavas and intercalated sediments of pre-Cambrian age.

The statistics of production in this country have been compiled by the United States Geological Survey from confidential reports by each mine in operation and represent the quantity of metals recovered or paid for in the ore that was treated or sold during the year.

Statistics of mine production were first collected for Michigan for 1906. The mine census of all of the Central States was first undertaken for the year 1907. A comparison of the total production of lead and zinc by States as reported by the mines and by the smelters will be found in the chapters on those metals in the complete volume.

The method of marketing and recording the mine output in the lead and zinc regions of the Central States differs from that employed in the Western States. In the Western States the miner usually sells his ore according to the assay content of metal at a certain price per unit. In the lead and zinc regions of the Central States, however, where the material sold is principally concentrates,[1] payment is made according to a basis price for a certain quality of concentrate. The details of this method are given in the pages devoted to Missouri. The figures reported to the Survey by producers represent the tonnage and assay content of cencentrates sold and the amount received in payment. The total metal produced is calculated from the first two of these items.

[1] In local usage the ore as mined is called "dirt" and the concentrates are classed as "ore."

The mines in Michigan report the quantity of concentrates produced and the actual recovery of copper from concentrates smelted. In any year the mines may produce more or less concentrates than are smelted during the same period. The copper content of concentrates produced during the year but not smelted has been estimated on the basis of the average copper recovery per ton for the year of the company producing it.

## TENOR OF LEAD AND ZINC ORES OF THE CENTRAL STATES.

Much of the ore mined in the Western States is crude smelting ore—that is, it can be smelted directly without preliminary concentration. All but a very small portion of the ore from the Central States is of such tenor that it requires concentration. The only fair basis for comparison of the relative magnitude of mining operations in different States is that of tonnage of crude ore, or "dirt," as it is usually called in the Central States lead and zinc regions. However, in those States it is only the larger companies which make any record of the crude ore raised. In the Joplin region the number of cans of ore hoisted is usually recorded and the approximate weight of the cans is generally known. Thus each company knows, in a general way, about what percentage of concentrates the mine run is yielding. Knowing the total production of concentrates and the average yield of concentrates from crude ores, one can arrive at a close estimate of the crude ore raised. The quantity of crude lead and zinc ores raised has been requested annually on the United States Geological Survey schedules since the mine census was undertaken in the Central States in 1907, and for many of the mines it has been reported. Only the actual operating companies have the data, however, and it is the practice of the Geological Survey, in order to shorten the list of producers as much as possible, to send requests only to the owners of the mining land or the companies holding first leases and to depend upon them to report the whole production of the tract. In this way the crude ore formerly reported was such a small fraction of the total that it was not considered advisable to use it. In 1909, however, the general census necessitated a report from every operator and the data in regard to crude ore were so much more complete that the average percentage of concentrates in the crude ore was calculated from those schedules in which the crude ore was given. This was done for each State, and in Missouri separate calculations were made for the "soft ground" and the "sheet ground" of southwest Missouri and for the disseminated lead ore of southeast Missouri. These average percentages were applied to the total concentrates produced, thus working back to the total quantity of crude ore raised. Since 1909 the data furnished upon the mine schedules have been sufficient to permit the continuance of the crude-ore calculations, which have been carried forward to include the year 1911. The tables of ore tenor which follow in the sections devoted to the respective States show the comparative percentages for the last two years. In certain States, notably Iowa, Kentucky, and the southern part of Illinois, it was not possible or advisable to make such calculations.

In Kentucky and southern Illinois the lead and zinc ores are recovered as by-products in the concentration of the fluorspar which

they accompany. In Iowa, in 1909, 1910, and 1911, the quantity of ore raised was so small and the number of producers so limited that the calculation of averages and of the crude-ore production would be misleading.

*Tenor of copper, lead, and zinc ores of Central States.*

| State. | 1909 | | 1910 | | 1911 | |
|---|---|---|---|---|---|---|
| | Crude ore. | Metal content.[a] | Crude ore. | Metal content.[a] | Crude ore. | Metal content.[a] |
| | *Short tons.* | *Per cent.* | *Short tons.* | *Per cent.* | *Short tons.* | *Per cent.* |
| Arkansas | 12,800 | 4.7 | 35,000 | 3.4 | 24,925 | 3.4 |
| Illinois (northern) | 73,875 | 4.2 | 110,078 | 3.8 | 153,313 | 3.6 |
| Kansas | 595,786 | 2.4 | 704,046 | 2.5 | 761,465 | 1.9 |
| Michigan | 11,429,394 | 1.06 | 10,869,561 | 1.025 | 10,978,827 | 1.0 |
| Missouri | 11,480,654 | 2.6 | 12,748,420 | 2.3 | 12,136,788 | 2.5 |
| Oklahoma | 317,574 | 3.9 | 223,212 | 4.0 | 224,450 | 2.9 |
| Wisconsin | 696,389 | 4.3 | 1,032,031 | 3.6 | 1,123,040 | 3.4 |

[a] The percentages given in this column represent the metal content of the ore in so far as it is recovered in the concentrates. In Michigan the metal so recovered is copper; in the other Central States the metals are lead and zinc, the relative proportions of which are shown in the table on another page and in the tables of ore tenor given in the sections devoted to the respective States.

## PRODUCTION.

### SILVER.

The production of silver in the Central States in 1911 was 550,184 fine ounces, which at the average price of 53 cents per fine ounce, had a value of $291,598 as compared with 365,702 fine ounces, valued at $197,479 in 1910. No silver ores are worked in the Central States and the silver that is produced is recovered incidentally to the production of other metals. Of the 1911 production 497,281 ounces came from the copper lodes of Michigan, an increase of 166,781 ounces. The lead ores of southeast Missouri yielded 49,867 ounces. The lead-zinc-fluorspar deposits of the Kentucky-Illinois field also carry silver, and from the lead concentrates derived from Illinois 3,036 ounces of silver were recovered.

### COPPER.

The output of copper from the Central States in 1911 was from the States of Michigan and Missouri, the former State contributing nearly the entire output. The copper production of Michigan in 1911 was 219,840,201 pounds, which, at the average New York price of 12.5 cents per pound, was valued at $27,480,013, compared with a yield of 222,683,461 pounds, valued at $28,280,800, in 1910. The copper produced in Missouri in 1911 amounted to 640,411 pounds, valued at $80,051, and was derived from concentrates recovered in dressing the lead ores of southeast Missouri.

### LEAD.

The mine production of lead in the Central States in 1911 was 188,669 short tons, which, rated at the average New York price for the metal for the year of 4.5 cents a pound ($90 a ton), was valued

at $16,980,210, as compared with 171,226 short tons, valued at $15,067,888, in 1910. Missouri produced 95 per cent of the yield of the Central States and about 44 per cent of the primary lead recovered in the United States from domestic ore. Of the total lead output of Missouri the disseminated lead district of southeast Missouri produced 147,754 tons, again exceeding the yield from the Cœur d'Alene district of Idaho and retaining its position as the largest producing lead district in the United States. Southwest Missouri was the next largest producing district in the Central States. There was a large increase in the output of lead in Illinois in 1911 when compared with the output of that State in 1910.

## ZINC.

The production of zinc in the Central States in 1911, based on mine returns with a deduction for separating and smelting losses, was 172,698 short tons, valued at $19,687,572. The value is computed at 5.7 cents per pound ($114 per ton), the average St. Louis price for the metal. The 1910 production was 178,784 short tons, valued at $19,308,672.

The State of Missouri was again the largest producer of zinc in the United States, although its production (122,515 tons) was slightly less than in 1910. The output from Wisconsin was 29,720 tons, which was 3,792 tons more than in 1910, and the production from Kansas and Oklahoma was less than in 1910.

## SUMMARY OF PRODUCTION BY STATES.

The total value of the output of silver, copper, lead, and zinc in the Central States in 1911 was $64,519,444, as appears from the following table:

*Production of silver, copper, lead, and zinc in the Central States in 1911, by States.*

| State. | Silver. | | Copper. | | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ounces.* | | *Pounds.* | | *Short tons.* | | *Short tons.* | | |
| Arkansas | | | | | 64 | $5,760 | 664 | $75,696 | $81,456 |
| Illinois | 3,036 | $1,609 | | | 964 | 86,760 | 4,219 | 480,966 | 569,335 |
| Iowa | | | | | 60 | 5,400 | | | 5,400 |
| Kansas | | | | | 2,859 | 257,310 | 10,272 | 1,171,008 | 1,428,318 |
| Kentucky | | | | | | | 158 | 18,012 | 18,012 |
| Michigan | 497,281 | 263,559 | 219,840,102 | $27,480,013 | | | | | 27,743,572 |
| Missouri | 49,867 | 26,430 | 640,411 | 80,051 | 178,868 | 16,098,120 | 122,515 | 13,966,710 | 30,171,311 |
| Oklahoma | | | | | 2,501 | 225,090 | 5,150 | 587,100 | 812,190 |
| Wisconsin | | | | | 3,353 | 301,770 | 29,720 | 3,388,080 | 3,689,850 |
| Total | 550,184 | 291,598 | 220,480,513 | 27,560,064 | 188,669 | 16,980,210 | 172,698 | 19,687,572 | 64,519,444 |
| Total, 1910 | 365,702 | 197,479 | 222,777,913 | 28,292,795 | 171,226 | 15,067,888 | 178,784 | 19,308,672 | 62,866,834 |
| Total, 1909 | 301,629 | 156,848 | 234,136,529 | 30,437,749 | 168,221 | 14,467,006 | 175,337 | 18,936,396 | 63,997,999 |
| Total, 1908 | 292,237 | 154,885 | 223,286,700 | 29,473,844 | 153,361 | 12,882,324 | 146,975 | 13,815,650 | 56,326,703 |

## LEAD AND ZINC PRODUCTION BY REGIONS.

The productive lead and zinc territory in the Central States naturally falls into seven regions, three of which are not limited to any single State. For statistical purposes the tables showing the production of lead and zinc by States are necessary and are so given. For practical purposes, however, it seems desirable to compile the production by the natural regions irrespective of State lines.

The seven regions are as follows in order of importance of output: (1) The Joplin region, comprising the district in southwest Missouri, southeast Kansas, and northeast Oklahoma; (2) southeast Missouri, containing the great disseminated lead deposits; (3) the upper Mississippi Valley region, including all the lead and zinc mines in southwest Wisconsin, Iowa, and northwest Illinois; (4) the Kentucky-Illinois fluorspar region in southern Illinois and northern Kentucky; (5) central Missouri (owing to the small output from this region for convenience it has in this report been included in the southeast Missouri region); (6) northern Arkansas; (7) the Arbuckle Mountain region in southern Oklahoma.

The southeast Missouri region produced 78 per cent of the lead output of the Central States and about 35 per cent of the production of lead from domestic ore in the United States in 1911. The Joplin region produced 19 per cent of the lead and 78 per cent of the zinc of the Central States in 1911, and was much the largest producer of zinc in the United States, yielding about 50 per cent of the total zinc production. The upper Mississippi region produced 2 per cent of the lead and 20 per cent of the zinc produced in the Central States in 1911.

*Production of lead and zinc in the Central States in 1911 by regions, in short tons.*

| Region. | Concentrates. | | | | Metal. | | | | Total value of metal. |
|---|---|---|---|---|---|---|---|---|---|
| | Lead.[a] | | Zinc.[b] | | Lead. | | Zinc. | | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| Joplin | 45,905 | $2,545,069 | 268,670 | $10,217,993 | 36,474 | $3,282,660 | 137,633 | $15,690,162 | $18,972,822 |
| Southeast Missouri[c] | 219,145 | 10,293,400 | 623 | 15,566 | 147,754 | 13,297,860 | 233 | 26,562 | 13,324,422 |
| Upper Mississippi Valley | 5,221 | 274,435 | 110,009 | 2,324,072 | 4,038 | 363,420 | 33,939 | 3,869,046 | 4,232,466 |
| Northern Arkansas | 80 | 4,321 | 1,590 | 44,664 | 64 | 5,760 | 664 | 75,696 | 81,456 |
| Kentucky - Southern Illinois | 482 | 21,205 | 467 | 10,604 | 339 | 30,510 | 158 | 18,012 | 48,522 |
| Arbuckle Mountain, Oklahoma | ..... | ..... | 220 | 3,643 | ..... | ..... | 71 | 8,094 | 8,094 |
| Total | 270,833 | 13,138,430 | 381,579 | 12,616,542 | 188,669 | 16,980,210 | 172,698 | 19,687,572 | 36,667,782 |

[a] Includes both galena and lead carbonate concentrates.
[b] Includes sphalerite, zinc carbonate, and zinc silicate concentrates.
[c] Includes a small production from the Central Missouri region.

## ARKANSAS.

By J. P. Dunlop.

### PRODUCTION.

The production of lead and zinc in Arkansas in 1911 is shown in the following table:

*Production of lead and zinc in Arkansas, 1908–1911, in short tons.*[a]

| District. | Ore. | | | | | | Metal content. | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lead concentrates. | | Zinc concentrates. | | | | Lead. | | Zinc. | |
| | Galena. | | Sphalerite. | | Silicate and carbonate. | | | | | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| North Arkansas: | | | | | | | | | | |
| 1911 | 80 | $4,321 | 1,407 | $40,425 | 183 | $4,239 | 64 | $5,760 | 664 | $75,696 |
| 1910 | 80 | 3,714 | 1,857 | 74,136 | 128 | 2,641 | 63 | 5,544 | 994 | 107,352 |
| 1909 | 30 | 1,800 | 896 | 33,948 | 98 | 2,736 | 24 | 2,064 | 510 | 55,080 |
| 1908 | 18 | 985 | 516 | 18,270 | 939 | 21,469 | 15 | 1,260 | 605 | 56,870 |

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses in case of zinc, but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the values given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

*Tenor of lead and zinc ore and concentrates produced in Arkansas, 1910–11.*

| | | 1910 | 1911 |
|---|---|---|---|
| Total crude ore | short tons | 35,060 | 24,925 |
| Total concentrates in crude ore | per cent | 5.9 | 6.7 |
| Lead | do | .2 | .3 |
| Zinc | do | 5.7 | 6.4 |
| Metal content of crude ore | do | 3.4 | 3.4 |
| Lead | do | .2 | .2 |
| Zinc | do | 3.2 | 3.2 |
| Average lead content of lead concentrates | do | 78.8 | 80.0 |
| Average zinc content of sphalerite concentrates | do | 58.1 | 50.2 |
| Average zinc content of zinc silicate and carbonate | do | 39.1 | 39.1 |
| Average value per ton of lead concentrates | | $46.43 | $54.01 |
| Average value per ton of sphalerite concentrates | | $39.92 | $28.73 |
| Average vlue per ton of zinc silicate and carbonate | | $20.63 | $23.16 |

### NORTHERN ARKANSAS.

Lead and zinc deposits have been known in Arkansas for many years. Lead was noted by Schoolcraft in his travels in 1819, and has been mined in a desultory way since the settlement of the State. Present development dates from about 1899, when there was a great rush to the northern Arkansas field. The mines are principally in Marion County and in the adjoining portions of Searcy, Newton, and Boone counties, though there are also numerous mines and prospects in Baxter, Izard, Sharp, Lawrence, and other counties to the east, and a deposit has recently been developed in Washington County, on the extreme west border of the State.

The ores are galena, sphalerite, and smithsonite. The sphalerite is generally very high grade, the concentrates, when clean, ranging well above the price basis, 60 per cent metallic zinc content. The

sphalerite and smithsonite are shown by analysis to contain appreciable quantities of cadmium, a yellow variety of smithsonite, known locally as "turkey fat," showing as high as eight-tenths of 1 per cent of cadmium. The ore bodies occur in fissures or crevices, in fault breccias, and in solution breccias. The ore deposits are for the most part found in the Yellville limestone, of Ordovician age, but some also are found in the Boone formation, of lower Carboniferous age.

Until the last two years the mines labored under the disadvantage of a long wagon haul to the railroad and of high freight rates. Other handicaps are the lack of keen competition among ore buyers and the added cost and the loss of time in obtaining supplies and repairs, though these conditions will doubtless improve with the development of the field. The completion of the White River branch of the St. Louis, Iron Mountain & Southern Railway and of the St. Louis & North Arkansas Railroad has brought most of the producing mines within 10 miles of railway transportation and greatly improved the situation in this regard. Land for mining purposes is ordinarily leased in 10-acre tracts at 10 per cent royalty. Wood is universally used for fuel at the mines. Since 1907 the number of steam concentrating plants in the northern Arkansas region has always been above 20, but usually not more than a third of them has been in operation in any one year. These are of the Joplin type, and average about 100 tons in daily capacity. Mining methods are similar to those in vogue in the Joplin region, except that, owing to the rugged character of the country, many deposits have been found outcropping on the hillside and have been followed in by tunnels. Shallow deposits are won by open pits. Hand drills are generally used, though a few of the larger plants have installed air or steam drills. Prospecting is done by means of the churn drill, and an encouraging feature of recent work has been the greater depth to which prospecting has been carried.

The assistance rendered by Prof. R. W. Willett in the preparation of this account of the lead and zinc production of Arkansas is gratefully acknowledged.

In 1911 there were 12 shippers of lead or zinc concentrates against 10 shippers in 1910. The quantity of lead concentrates shipped equaled that for 1910, and the zinc carbonate and silicate concentrates showed a small increase over shipments in 1910.

The production of sphalerite concentrates decreased more than 400 tons compared with 1910. Development work and mill construction were more active, especially during the latter part of the year so that the production will likely show a substantial gain in 1912.

The percentage of concentrates per ton of crude ore increased from 5.9 in 1910 to 6.7 in 1911, while the metal content in crude ore remained the same as in 1910. The production of a quantity of mixed sphalerite and zinc carbonate and silicate concentrates lowered the average grade of the concentrates and reduced the average price paid for sphalerite concentrates, when compared with those for 1910.

### REVIEW BY DISTRICTS.

*Dodd City district.*—There were a few scattered sales of both lead and zinc concentrates from this district reported in 1911. The Rising Sun, North Star, Onwatta, Beatty, Boone County, Pilot Rock, and Nakomis mines were all idle. At the Governor Eagle

mine shaft sinking was commenced after prospect drilling ha defined the location of the ore body.

*Maumee district.*—The Maumee mine of the North Arkansas Min ing & Investment Co. reported the sale of sphalerite concentrate averaging 60.2 per cent zinc content and also some very high-grad zinc carbonate and silicate. The shaft at this mine is 138 feet deep and the property is equipped with a 100-ton (10-hour shift) con centrating plant, which was only operated during the early par of 1911.

Lessees on land owned by the Granby Mining & Smelting Co shipped a large portion of the lead concentrates and the zinc silicate concentrates produced in Arkansas in 1911. Both the lead and the zinc concentrates were high grade. Three shafts averaging 80 feet deep were operated.

*Rush Creek district.*—The mines in this district in Marion County produced about 85 per cent of the sphalerite concentrates shipped from Arkansas in 1911. The Philadelphia mine, operated by the Yellow Jacket Mining Co., was the largest producer in the State. The crude ore is extracted through a tunnel, and the property is equipped with a 100-ton (10-hour shift) concentrating plant.

The Red Cloud Mining Co. operated a 200-ton concentrator and shipped a large tonnage of sphalerite concentrates. The mine is opened up by a 600-foot tunnel.

The Morning Star Mining Co. made no shipments of concentrates, but opened up the mine and erected a 250-ton concentrator.

*Zinc and Sugar Orchard districts.*—The Coker Hollow Mining Co. was the largest producer of zinc concentrates in these districts in 1911. Although the shaft at this mine is down 110 feet, all the ore treated was hoisted from drifts ranging from 30 to 60 feet underground. The Tar Kiln mine of the Federal Exploration Co. shipped some high-grade sphalerite concentrates. This mine is equipped with a 100-ton (10-hour shift) mill. An Ingersoll-Rand compressor and air drills were added to the plant. The Isabel shaft was sunk 15 feet deeper during the year, and considerable drifting was done on the 70-foot level.

The J. E. Wheeler lease on land of the Washington Mining Co. was the largest individual producer of lead concentrates in Arkansas in 1911. In addition to the hand-cobbed ore shipped there was a large quantity of lead ore hoisted that will require milling.

The Frisco mine was being developed and will be a shipper early in 1912.

Development work was continued at the Lincoln mine near Smithville. Some ore was hoisted, but the 100-ton mill was not operated.

*Morrow district.*—A small quantity of very high-grade concentrates was shipped by the Washington County Lead & Zinc Co. from its property near Morrow, in Washington County, on the extreme western border of the State. The mining so far has been in shallow ground and the ore was hoisted through one shaft. A new 150-ton mill (10-hour shift) was partly erected in 1911.

*Ponca district.*—There were a number of prospects operated in this district in 1911. Both lead and zinc ores were mined, but shipments were retarded by poor transportation facilities. The only shipment was one of zinc silicate made by N. B. Whiteley.

## ILLINOIS.

By J. P. Dunlop.

### PRODUCTION.

The production of lead, zinc, and silver in Illinois in 1911 is shown in the following tables:

*Production of lead and zinc in Illinois, in 1911, in short tons.*[a]

| District. | Ores. | | | | Metal content. | | | |
|---|---|---|---|---|---|---|---|---|
| | Lead concentrates, galena. | | Zinc concentrates, sphalerite. | | Lead. | | Zinc. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Northern Illinois (Galena)... | 787 | $41,220 | 11,011 | $320,806 | 625 | $56,250 | 4,219 | $480,966 |
| Southern Illinois..... | 482 | 21,205 | ..... | ..... | 339 | 30,510 | ..... | ..... |
| State, total..... | 1,269 | 62,425 | 11,011 | 320,806 | 964 | 86,760 | 4,219 | 480,966 |
| Total, 1910..... | 524 | 24,319 | 9,871 | 249,496 | 373 | 32,824 | 3,549 | 383,292 |

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses in case of zinc, but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

*Production of silver in southern Illinois, 1909–1911.*

| Year. | Silver. | | Lead concentrates, silver-bearing. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Ounces of silver per ton. |
| | *Fine ounces.* | | *Short tons.* | |
| 1909..... | 1,011 | $526 | 259 | 3.903 |
| 1910..... | 2,022 | 1,092 | 398 | 5.08 |
| 1911..... | 3,036 | 1,609 | 482 | 6.25 |

*Tenor of lead and zinc ore and concentrates produced in Illinois, 1910 and 1911.*

| | 1910 | 1911 |
|---|---|---|
| Northern Illinois: | | |
| Total crude ore.....short tons.. | 110,078 | 153,313 |
| Total concentrates in crude ore: | | |
| Lead.....per cent.. | 0.1 | 0.6 |
| Zinc.....do.... | 8.9 | 7.2 |
| Metal content of crude ore: | | |
| Lead.....do.... | .1 | .4 |
| Zinc.....do.... | 3.7 | 3.2 |
| Average lead content of galena concentrates.....do.... | 80.2 | 79.4 |
| Average zinc content of sphalerite concentrates.....do.... | 44.2 | 45.3 |
| Average value per ton of galena concentrates..... | $54.36 | $52.37 |
| Average value per ton of sphalerite concentrates..... | $25.28 | $29.13 |
| Southern Illinois: | | |
| Average lead content of galena concentrates.....per cent.. | 68.3 | 70.0 |
| Average value per ton of galena concentrates..... | $43.89 | $44.00 |

The lead concentrates produced in southern Illinois are recovered in concentrating the flourspar. To speak of the total crude ore raised as crude lead ore would be misleading. No attempt has been made, therefore, at calculating the tenor of the crude ore.

The value of the mine production of silver, lead, and zinc in Illinois in 1911 was $569,335, an increase of $152,127, or 36 per cent, over the output for 1910. The lead concentrates produced amounted to 1,269 tons, which was 745 tons more than in 1910, and the metal content increased from 373 tons in 1910 to 964 tons in 1911.

The zinc concentrates increased from 9,871 tons in 1910 to 11,011 tons in 1911, and the recoverable zinc content of the concentrate increased from 3,549 tons in 1910 to 4,219 tons in 1911.

The silver recovered amounted to 3,036 fine ounces, valued at $1,609, against 2,022 fine ounces, valued at $1,092, in 1910.

The lead and zinc deposits of Illinois fall into two distinct regions marked by different mineralogical association and structural environment. Those of southern Illinois belong to the Kentucky-Illinois fluorspar district; those of northern Illinois belong to the upper Mississippi Valley region.

## NORTHERN ILLINOIS.

The lead and zinc mines of northern Illinois are all in Jo Daviess County, the extreme northwest county of the State. The ores have the same structural relations as in the upper Mississippi district generally; that is, they occur disseminated through the limestone, or in openings in it called "crevices," "pitches," or "flats," depending on their attitude to the horizontal. These openings have in general an east and west trend, known as their range. The ore bodies are sometimes continuous for long distances along these ranges, which for that reason largely control the prospecting, both by shafts and by drilling. The ore deposits occur in the Galena dolomite and in the upper part of the Platteville limestone, both of Ordovician age. The ores are galena, sphalerite, and smithsonite, though the latter is much less common now than formerly, when the deposits worked were mostly shallow and above water level. The galena is practically nonargentiferous, and the zinc ores are not known to contain cadmium. Iron pyrite is very commonly associated with the ores, frequently in such quantity as to necessitate roasting and magnetic separation. Some of the concentrating plants have calciners or roasters and magnetic separators attached, and there is a custom roaster and separator operated by the Joplin Separator Co., at Galena, Ill. There were also separating plants operated near by in Wisconsin by the Campbell Magnetic & Separating Co. at Cuba City, the National Zinc Separating Co. at Hazel Green, the Wisconsin Separating Co. at Benton, and the electrostatic separator of the American Zinc Ore Separating Co. at Platteville. The last-named separator and also the custom separator at Galena were destroyed by fire in October, 1911.

As none of the mines in the Elizabeth and Sand Prairie districts reported any production in 1911, the entire output of northern Illinois was from the Galena district. The production of lead concentrates was 787 tons, valued at $41,220, as compared with 126 tons, valued at $6,849, in 1910.

There were 11,011 tons of zinc concentrates valued at $320,806 produced in 1911, an increase of 1,140 tons in quantity and of $71,310 in value compared with the output in 1910. A large portion of the increased value was due to the fact that the average price per ton received for sphalerite concentrates was $3.85 more than in 1910.

The tonnage of crude ore mined increased from 110,078 tons in 1910 to 153,313 tons in 1911. The per cent of zinc concentrates in the ore milled showed a decrease while the lead showed a large increase.

### REVIEW BY DISTRICTS.

*Elizabeth and Sand Prairie districts.*—Very few of the mines in these districts were operated, and no output of zinc was reported. The Haggerty mine, at Elizabeth, and the Scales Mound-Rockford Mining & Milling Co. did a small amount of development work. The concentrating plant at the Wishon mine was sold and removed from the property.

*Galena district.*—This district includes the mines in the vicinity of Fever River, from Mississippi River to the Wisconsin State line. Though formerly a large producer of lead, the district now produces zinc ores principally. The largest producer of zinc concentrates in Illinois was the Vinegar Hill Zinc Co., operating the Vinegar Hill and Unity mines. The shaft at the Vinegar Hill mine is 175 feet deep, and the mine is equipped with a 100-ton (10-hour shift) concentrating plant. The Unity mine also has a 100-ton plant. Both mills are supplied with electric power from the Interstate Light & Power Co. Some prospect work was done by the Vinegar Hill Zinc Co. on the Hughlett & Gray property. The Northwestern Zinc Co.'s property was operated only during the last two months of the year. The concentrates produced were sold to the Wisconsin Separating Co., of Benton, Wis. The shaft at this mine is 190 feet deep and the concentrating plant has a capacity of 100 tons per 10 hours.

The Ten Strike Consolidated Mining Co. operated the Ten Strike, White Rose, and Merry Widow mines, producing some zinc concentrates and the largest output of lead concentrates in the upper Mississippi Valley region. The Ten Strike has a small 20-ton (10-hour shift) mill, and the Merry Widow was equipped with a 100-ton (10-hour shift) concentrating plant purchased in 1911. The shaft on the Ten Strike is 153 feet and that on the Merry Widow 71 feet deep. The White Rose mine shows good lead ore in the shaft at the 35-foot level.

The Pilot Knob mine was purchased and will be operated by the Glenridge Lead & Zinc Co.

The Weinschenk mine was worked through two shafts, 102 and 72 feet deep, and a good production of lead concentrates was sold.

### SOUTHERN ILLINOIS.

The lead and zinc deposits of southern Illinois are found in Pope and Hardin counties in rocks of lower Carboniferous age, in the northern extension of the Kentucky-Illinois fluorspar district. The structural relations and the mineralogic association are similar

to those of the deposits of western Kentucky and in striking contrast to those of the deposits of northern Illinois. The ores occur in fissure veins, in association with jointing and faulting. The mines have been worked to depths of 300 and 500 feet without disclosing any decrease in the dimensions of the ore bodies. Dikes and sheets of lamprophyre and dikes of mica peridotite occur in the vicinity, but not in direct connection with the ore deposits. Galena is the most important metallic mineral. Formerly, and nearer the surface, large bodies of galena were worked, but it is at present produced incidentally in the concentration of the fluorspar. For this reason it would be misleading to give the tonnage of crude ore. As the district is not reached by railway the product of the mines is dependent on river transportation.

The galena of southern Illinois is notably argentiferous as compared with the rest of the Mississippi Valley ores, the silver content ranging up to 12 and 14 fine ounces per ton of lead concentrates, and averaging for the last three years from 4 to 6.28 fine ounces per ton of lead concentrates. The average silver content recovered from lead concentrates in 1911 was 6.28 ounces and the total quantity recovered 3,036 ounces. Sphalerite, or zinc blende, is the next important metallic mineral, but it occurs much less plentifully than galena. It is recovered as zinc middlings in the concentration of the fluorspar. The difficulty of making a clean separation of the zinc middlings has kept down the production of zinc. None has been sold from southern Illinois in the last four years. The principal vein minerals are fluorspar, calcite, and barite.

Many of the fluorspar mines in the southern Illinois district were reported idle in 1911 and others sold no lead concentrates, although some were produced by them. The lead concentrates increased 84 tons in quantity, and the silver content recovered in treating the concentrates increased from 2,022 fine ounces in 1910 to 3,036 ounces in 1911. The Fairview and Rosiclare mines were the principal producers in this district.

The Fairview Fluorspar & Lead Co. operates on the Good Hope vein, which was first developed in 1862. The workings are reached by means of four shafts, of which the Good Hope is 500 feet deep; No. 4, 210 feet deep; Blue Diggings, 150 feet deep; and Extension, 100 feet deep. A large part of the lead came from Extension and No. 4 shafts. Underground work at the Extension shaft disclosed new ore bodies, and hoisting equipment was installed. The concentrating plant has a capacity of 200 tons per 10-hour shift.

The Rosiclare Lead & Fluorspar Co. operates on an ore body which is probably continuous with that of the Fairview. The workings have reached a depth of 300 feet, and the mine has a long record of continuous production. A new steel and concrete mill, entirely fireproof, has been built at Rosiclare, designed to handle 500 tons a day and provided with special facilities for saving the lead and zinc.

## IOWA.

By J. P. Dunlop.

### PRODUCTION.

The production of lead and zinc in Iowa in 1911 is shown in the following table:

*Production of lead and zinc in Iowa in 1911, in short tons.*[a]

| District. | Ore. | | | | | | Metal content. | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lead concentrates. | | Zinc concentrates. | | | | Lead. | | Zinc. | |
| | Galena. | | Sphalerite. | | Carbonate. | | | | | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Dubuque: | | | | | | | | | | |
| 1911 | 75 | $3,750 | ..... | ..... | ..... | ..... | 60 | $5,400 | ..... | ..... |
| 1910 | 25 | 1,320 | 245 | $5,740 | ..... | ..... | 20 | 1,760 | 96 | $10,368 |
| 1909 | 45 | 2,079 | ..... | ..... | 100 | $1,500 | 36 | 3,096 | 35 | 3,780 |
| 1908 | 63 | 3,613 | 829 | 23,183 | ..... | ..... | 51 | 4,284 | 395 | 37,130 |

[a] In calculating the metal content of the ore from assays, allowance has been made for smelting losses in the case of zinc, but not in the case of lead. In comparing the value of ore and metal content it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

It is not deemed advisable to publish figures of the total crude-ore production of Iowa for either 1910 or 1911. The production of sphalerite concentrates in 1910 was practically all from the Avenue Top mine. The output of other concentrates for both years was made up of small lots obtained as the result of development work, and these are not a fair clue to the average ore tenor. As noted below, the ores occur under much the same condition as in Wisconsin, and the averages reached for that State would hold reasonably well for Iowa.

The lead and zinc deposits of Iowa extend along Mississippi River for nearly 80 miles in Dubuque, Clayton, and Allamakee counties. They are found in the Galena dolomite, of Ordovician age. In early days the Dubuque mines were the most important source of lead in the United States, and in later years the mines, especially those in the vicinity of Durango, yielded considerable quantities of zinc carbonate ore. Nearly all this earlier mining was done above water level, and only within the last few years has there been much attempt to mine below water level. Therefore the production, particularly of zinc-blende ore for these years, though small, is noteworthy, since it represents the attempt to mine at deeper levels.

The ore deposits of the Dubuque district occur in crevices and in caves or "openings" along these crevices. Of these openings there are five or six, the "top," "middle," and "third" being the most prolific of ore. The "flats" and "pitches" common in the Wisconsin mines have been found in only one or two instances in Iowa. The crevices have an east-west trend, and sometimes extend considerable distances, being mined at different places, in which case they are

known as "ranges." The mining operations of recent years have generally been confined to attempts to find paying ore at deeper levels in these old ranges which are known to have yielded ore in former days in the upper openings.

The only production of lead in the Dubuque district in 1911 was 75 tons of lead concentrates, sold in small lots. No sales of sphalerite concentrates were reported. The Aguanico Mines Development Co. (formerly the Avenue Top), in the western part of Dubuque, which was a producer in 1910, did not operate either the workings or the 100-ton concentrating plant. The Bellman, Bray, Busy Bee, Big Joe, Byrne & Saul, Grand View, Harriman, Lore, Larcombe, Peacock, and Weston mines were idle the entire year. The Miller mine produced a small tonnage of lead concentrates, and the Riley & Rosner and Isborn mines were operated only for brief periods.

The Goosehorn mine has no concentrating plant, but hoists ore from the 192-foot level. One shaft is down 192 feet and another 160 feet, and electric power is used for hoisting.

Most of the lead ore came from prospects operated by means of shallow shafts, the miners being paid a certain daily wage and a portion of the selling price of the lead recovered. Many of the large companies ceased operating and surrendered their charters. Some lead will continue to come from the small mines, but the present outlook is not favorable for any larger output of zinc from the deep workings.

## KANSAS.

By J. P. Dunlop.

### PRODUCTION.

The production of lead and zinc in Kansas in 1911 is shown in the following table:

*Production of lead and zinc in Kansas in 1911, by districts, in short tons.*[a]

| District. | Ores. | | | | | | | | Metal content. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lead concentrates. | | | | Zinc concentrates. | | | | Lead. | | Zinc. | |
| | Galena. | | Carbonate. | | Sphalerite. | | Carbonate and silicate. | | | | | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Badger - Peacock and Lawton[b] | 134 | $6,902 | ..... | ..... | 2,517 | $92,726 | ..... | ..... | 107 | $9,630 | 1,333 | $151,962 |
| Galena | 3,487 | 190,950 | ..... | ..... | 17,770 | 641,422 | 122 | $2,916 | 2,752 | 247,680 | 8,939 | 1,019,046 |
| State total: | | | | | | | | | | | | |
| 1911 | 3,621 | 197,852 | ..... | ..... | 20,287 | 734,148 | 122 | 2,916 | 2,859 | 257,310 | 10,272 | 1,171,008 |
| 1910 | 2,973 | 144,284 | 61 | $2,496 | 27,134 | 998,219 | 106 | 1,452 | 2,412 | 212,256 | 13,229 | 1,428,732 |

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses in case of zinc but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

[b] It is necessary to combine the production of the Badger-Peacock and the Lawton districts to avoid disclosing individual returns.

*Tenor of lead and zinc ore and concentrates produced in Kansas, 1910 and 1911.*

| | | 1910 | 1911 |
|---|---|---|---|
| Total crude ore | short tons | 704,046 | 761,465 |
| Total concentrates in crude ore: | | | |
| Lead | per cent | .4 | .5 |
| Zinc | do | 3.9 | 2.7 |
| Metal content of crude ore: | | | |
| Lead | do | .3 | .4 |
| Zinc | do | 2.2 | 1.5 |
| Average lead content of galena concentrate | do | 79.8 | 78.9 |
| Average lead content of lead carbonate concentrates | do | 62.3 | ..... |
| Average zinc content of sphalerite concentrates | do | 55.3 | 56.0 |
| Average zinc content of zinc silicate and carbonate | do | 34.0 | 38.5 |
| Average value per ton of galena concentrates | | $48.53 | $54.64 |
| Average value per ton of lead carbonate concentrates | | $40.92 | ..... |
| Average value per ton of sphalerite concentrates | | $36.79 | $36.19 |
| Average value per ton of zinc silicate and carbonate | | $13.70 | $23.90 |

The lead and zinc deposits of Kansas, so far as developed, are limited to the southeastern portion of the State, in Cherokee County. They comprise the western extension of the ore deposits of the Joplin region and display the general characteristics of that area, except that here typical sheet-ground deposits have not been extensively developed. The ores are galena and lead carbonate, sphalerite or zinc blende, and zinc carbonate and silicate. The galena is practically nonargentiferous, carrying but a small fraction of an ounce of silver to the ton of lead concentrates.

The value of the mine production of lead and zinc in Kansas in 1911 was $1,428,318, which is $212,670 less than the value of the 1910 output. This decrease was due mainly to the very much lessened shipments of both lead and zinc concentrates from the Badger-Peacock district.

The production of lead concentrates, however, increased 587 tons in quantity and $51,072 in value compared with the production for 1910. The percentage of lead in the crude ore milled increased from 0.4 per cent in 1910 to 0.5 per cent in 1911, while the selling price averaged about $6 per ton more than in 1910.

The production of zinc concentrates in 1911 amounted to 20,409 tons (of which 122 tons was zinc carbonate and silicate), which was 6,831 tons less in quantity and $262,607 less in value than in 1910.

The true measure of conditions in the zinc mining districts is best shown by the quantity of crude ore hoisted and milled and the amount of development work done. The quantity of "dirt" or crude ore hoisted increased from 704,046 tons in 1910 to 761,465 tons in 1911, notwithstanding the idleness of most of the Badger-Peacock mines. A larger quantity of lower-grade ore was mined and milled than in previous years. This is clearly indicated in the table giving the tenor of the ore and concentrates for 1910 and 1911.

The increased proportion of lead concentrates occurring in conjunction with a much lessened proportion of zinc concentrates was occasioned by the increased quantity of lead recovered from blanket ground. The more extensive operation of this ground contemplated in 1912 will likely result in further emphasizing this condition. There were many small operators in 1911 working tailings or small patches of new ground and the quantity of "dirt" sold or treated in custom mills was large but appreciably less than in previous years.

The breaking of the Murphy flume on Short Creek and the consequent flooding of the mines adjacent thereto partly accounted for the reduced output in 1911.

The ownership or management of many tracts of mining land changed hands and heavier pumping equipment was installed on many properties to render ore on the lower levels accessible. There was an extensive drilling campaign conducted at Lawton, and the shipment of concentrates was commenced in the middle of the year. None of the mines in the Playter district was active in 1911.

*Badger-Peacock district.*—On account of the necessity of combining the 1911 production of the Badger-Peacock and the Lawton districts in order to avoid disclosing the output of a single producer at Lawton, the exact decrease in the Badger-Peacock district can not be given, but roughly stated the value of the lead was only 20 per cent and the value of the zinc 27 per cent of the 1910 production. One of the reasons for the decreased output on this district was the flooding of the mines of the largest producing companies in the spring of the year, entailing serious delay until heavier pumping equipment could be installed.

Most of the production for 1911 was shipped by the S. H. & S. Mining Co. and the Peacock Valley Mining Co., both operating on the United Zinc Co.'s land.

The crude ore was hoisted from five shafts, the deepest of which was down 170 feet. The S. H. & S. Mining Co.'s mill, having a capacity of 200 tons (10-hour shift), was in operation about six months of this year. The Peacock Valley mill has a capacity of 150 tons per shift and ore was hoisted by several sublessees from the 140-foot level. The Thomas D. Mine, on the Federated lease, produced some concentrates from ore taken out of an open cave.

The Riverside Mining Co., on a sublease of the S. H. & S. Mining Co., made a small output of a concentrate from ore hoisted from an 85-foot shaft.

There was very little prospecting work done on the land of the Middlesex Land & Mining Co., and the only producers in 1911 were the Badger and Red Rose mines. Two shafts were operated at the Badger, and the ore was mined at the 150-foot level. The Badger concentrator has a capacity of 100 tons (10-hour shift).

*Lawton district.*—This district is situated 3½ miles north of Badger-Peacock and 14 miles northwest of Joplin and was first prospected about 1900. It remained dormant until the latter part of 1910, when the Eastern Lead & Zinc Co. leased a large acreage, prospected its leasehold by means of churn drills, and sunk a shaft. The quantity of water encountered in the shaft required the installation of pumps of large capacity and delayed production. The 300-ton electrically equipped concentrating plant turned out its first concentrates in June, 1911, and the production was good for the last months of the year. Many leases were granted by the Eastern Lead & Zinc Co., the ground was prospected thoroughly, and it is probable that the district will show a largely increased output of both lead and zinc in 1912.

*Galena district.*—The production of lead concentrates in the Galena district was 3,487 tons, compared with 2,508 tons in 1910. The shipment of zinc concentrates (all of which was sphalerite except 122 tons) was 17,892 tons, a decrease of 3,062 tons.

The 1911 value of the lead and zinc concentrates sold was only $20,791 less than in 1910. An increased tonnage of ore was milled, and if the mines in Short Creek valley had not been flooded by the breaking of the Murphy flume the value of the concentrates sold by the district would have shown an increase. The lessened value of the output of zinc in the Galena district should not be construed as an indication of a declining field, for the development of new mines and the opening of old properties were more general than for several years. Better pumping facilities were installed on many tracts and ore that formerly could not be extracted was rendered available. The Murphy flume has been reconstructed in a more substantial manner, and the new mills erected during 1911 will add to the 1912 output.

The Diplomat mine, on the Galena Lead & Zinc Co.'s land, was the largest producer of concentrates in the district in 1911. The ore lies in a sheet formation and when milled yields 2.6 per cent of concentrates in about the proportion of 4 of sphalerite to 3 of galena. The face of the ore is about 10 feet high. There are two 100-foot shafts, one of which is used exclusively to hoist the "dirt," of which 106,581 tons were hoisted in 1911 at a reported power cost of 10.5 cents, labor cost of 40.06 cents, and powder cost of 17.28 cents. More than 1,000 cans, or about 500 tons, of dirt were hoisted in one 9-hour shift in November. The concentrating plant has a capacity of 200 tons (10-hour shift), and over 500 tons of dirt have been treated inside 24 hours. The mill, hoists, drills, and other machinery are all operated by electric power. The company sunk a new shaft and has purchased another mill, which is under construction.

The Lockport Mining Co., holding leases on the Arthur, Brinkerhoff, Cooper, Ryan & Moeller, Murphy, Schmuck, Windsor, and Empire lands, was a large producer. A large proportion of the output came from the Windsor land, on which there were 3 mills. The subleases on the Windsor were the Mess, Open Cut, Phillips, and Holden. The production from the Empire Zinc Co.'s land, on which there are two shafts and a 250-ton mill, was also large.

The Illinois Lead & Zinc Co.'s land was the largest producer of sphalerite concentrates, but the ore carries very little galena. Among the lessees on this land are the Bloomington, Mokas, Clara Louise, and Peacock-Galena, the last of which was the most extensively operated. There are three shafts of 69, 70, and 115 feet on the Peacock-Galena, and the mill has a capacity of about 120 tons (10-hour shift).

The Clermont Land & Mining Co., operating one of the few sheet ground mines in the district, produced the usual quantity of high-grade concentrates. The ore was hoisted from the 185-foot level and milled at the 150-ton mill (10-hour shift). A new ore body was located, by drilling, about 400 feet from the present workings.

Two concentrating plants were operated on the Southside tract, leased to the Playter Mining Co., which was the second largest producer of lead in the district. The land also produced a large quantity of sphalerite concentrate.

The Latawanna and its lessees operated six shafts, averaging about 100 feet, and made regular shipments.

The Nymo 200-ton mill (10-hour shift), on the Bayne land, was operated from May to October, when the mill was sold and removed from the property.

The Murphy Mining & Realty Co.'s land was operated by several lessees, of whom Parker & Co. and Phelps & Co. were the largest producers.

The old Prudential property was sold to the Harmon Mining Co. A 100-ton mill on the lease was rebuilt and some concentrates made after difficulty in unwatering the workings.

The Ping & Robertson land was purchased by the Eureka Mining Co. and a quantity of high-grade sphalerite concentrates was shipped. The shaft at this mine is 266 feet deep and the mill has a capacity of 150 tons (10-hour shift).

A new 150-ton mill was erected on the Cromwell tract of the Playter Mining Co. by the Amboy Zinc Co.

Late in the year the Harvey-Shomon land was leased to the Pilsner Mining Co., the workings were pumped out, and a 100-ton (10-hour shift) mill was built and operated.

The Bonanza tract west of Galena, near the cemetery, was purchased by Henry Weyman, and some production was made by small lessees. Other producers of concentrates in 1911 were W. H. P. Clement on the Connor land, the Glick Land & Mining Co., Electric Light Plant Mining Co., Merchants Mining Co., New Century Lead & Zinc Co., Ohio Mining Co., and Boston Land & Mining Co. Most of the carbonate and the silicate of the zinc concentrates was produced by Ryan & Griggsby from a lease on the Raines land, and the largest custom mills operated were those of Friel & Phillips, G. C. Monlux, and C. W. Squires.

## KENTUCKY.

By J. P. Dunlop.

### PRODUCTION.

Lead and zinc deposits are found in both central and western Kentucky. None of the mines in Franklin, Mercer, Scott, Owen, or Henry counties, in the central districts reported any lead or zinc concentrates shipped in 1911. The mines in the fluorspar region of western Kentucky are chiefly in Crittenden, Caldwell, and Livingston counties and form a continuation of the southern Illinois lead and zinc region. Considerable quantities of galena ores have been produced in former years, but at the present time lead is obtained solely as a by-product in the recovery and concentration of fluorspar, which is the principal economic mineral. The galena recovered is argentiferous, the silver content varying from a very small quantity to over 3 ounces per ton.

Some galena concentrates were recovered during 1911, but none were reported as shipped to smelters, consequently no output of lead or silver is credited to Kentucky in 1911. The lead concentrates shipped in any one year from Kentucky do not necessarily represent the actual recovery of lead from fluorspar mined in that year, for, being merely accessory to the fluorspar and produced in small quantities, it is frequently held until a considerable quantity has accumulated or until lead prices are high.

The production of zinc carbonate concentrates in Kentucky amounted to 467 tons, valued at $10,604 and having a recoverable

zinc content of 158 tons. As only 30 tons were shipped in 1910, this production shows a substantial increase.

The Mann mine, near Lola, in Livingston County, was developed by Edmund Langenback. Two shafts, the deepest of which is 102 feet, were operated and some carbonate ore was produced.

The La Rue Co. was developing the McDowell mine, which adjoins the Mann mine, near Lola, and also the La Rue mine, near Levias, in Crittenden County. The 55-foot shaft at the McDowell mine was being sunk to the 100-foot level. During 1911 the shaft on the La Rue was sunk from the 165-foot level to the 200-foot and a drift run at the 140-foot level. Some fluorspar and sphalerite was hoisted during development.

The old Tabb mine, now owned by the Hoosier Mining Co., was operated through 4 shafts, ranging from 60 to 100 feet in depth. High-grade ore was encountered at 88 feet, and although no shipments of concentrates were made in 1911 the owners reported that both lead and zinc concentrates would be sold in 1912.

The Eclipse Mining Co.'s 40-ton concentrating plant, which had been used for milling fluorspar, was not operated in 1911, the spar having changed to zinc below the 100-foot level. The shaft was sunk to 185 feet and a drift run at the 150-foot level, which opened up the zinc ore body.

The Roberts Fluorspar Co. continued the development of the Keystone land and produced some lead concentrates.

## MICHIGAN.

By B. S. Butler.

### PRODUCTION.

In 1911 the mines of Michigan produced 219,840,201 pounds of copper, valued at $27,480,013, and 497,281 ounces fine of silver, valued at $263,559, a total value in copper and silver of $27,743,572. This is a decrease of $715,698 in value, or about 2.5 per cent, from the production of 1910. The decrease in the value of the mineral output was due to a slight decrease in the production of copper, and also to a slight falling off in the price of that metal. There was an increase in both the quantity and the value of the silver production. For 1910 the average price of copper per pound was $0.127, and for 1911 it was $0.125. The average price of silver for 1910 was $0.54 per fine ounce, and for 1911 it was $0.53. Owing to the slight decrease in the price of copper there was a decline from $2.54 in 1910 to $2.50 in 1911 in the average value per ton of rock treated.

The smelter production, or the output of refined copper, for 1911 was 218,185,236 pounds, as compared with 221,462,984 pounds in 1910. The difference between the mine and the smelter production is due to the fact that the quantity of mineral produced is not exactly the same as the quantity smelted. A company may produce either more or less mineral than it smelts during the year.

The following table shows the average values in copper and silver of rock treated in 1910 and 1911:

*Value of silver and copper product of Michigan mines in 1910 and 1911.*

| Year. | Silver. | Copper. | | Combined silver and copper, total value. |
|---|---|---|---|---|
| | | Value. | Value per ton of rock. | |
| 1910 | $178,470 | $28,280,800 | $2.54 | $28,459,270 |
| 1911 | 263,559 | 27,480,013 | 2.50 | 27,743,572 |
| Increase (+) or decrease (−) | +85,089 | −800,787 | −.04 | −715,698 |

The entire Michigan output of copper and silver is from the Keweenaw district. Both metals occur native in lodes remarkable for their great extent and uniformity. These lodes may be divided into two general classes: The amygdaloid, in which the metals occur together with gangue minerals, epidote, calcite, zeolites, etc., in the cellular portions of lava flows, and the conglomerate, in which the metals and gangue minerals cement and to some extent replace the pebbles forming the conglomerate. Native copper and copper minerals occur in fissures in the district, but at the present time the output from this type of deposit is of little importance. The "rock"[1] is of low grade and requires milling, which produces "mineral" carrying an average of about 65 per cent copper. A small quantity of "barrel" and "mass" copper is sorted at the mines and sent direct to the smelters.

In 1911 there were 10,978,827 short tons of rock milled, which yielded 338,908,308 pounds of "mineral" and 219,840,201 pounds of copper.[2]

The recovery of refined copper per ton of rock milled in 1911 was 20 pounds, as compared with 20.5 pounds in 1910.

There were 496,768 ounces of silver derived from the electrolytic treatment of 43,755,777 pounds of copper. This electrolytic copper was recovered from approximately 2,300,000 tons of rock, an average of 0.216 fine ounce of silver per ton of rock. In addition to the silver recovered by the electrolytic treatment of copper, 513 ounces were obtained as "pickings" from about 75,000 tons of rock. In the "pickings" only a portion of the silver contained in the rock is recovered.

[1] Some of the terms used to designate the different materials entering into the mining industry differ for the Lake district from those employed in any other part of the country. Ore is known as "rock" or "copper ground" (if unmined); the product of concentration is known as "mineral"; the term "ore" is used to designate the copper minerals (arsenides, sulphides, etc.) that occur to a limited extent in the district. Large bodies of native copper are known as "mass," and smaller ones are designated as "barrel work." In this report the local terms will be used, as it does not seem desirable to employ the more usual terms to the exclusion of the local, while a mixture of the two is confusing.

[2] The figures are based on the actual recovery of copper from "mineral" smelted and the estimated recovery from "mineral" that was not smelted during 1911.

The following table shows the production of metal, "mineral," and "rock" in Michigan for 1910 and 1911:

*Production of silver, copper, "mineral," and "rock" in Michigan in 1910 and 1911.*

| Year. | Silver. | Copper. | | "Mineral." | | "Rock." |
|---|---|---|---|---|---|---|
| | | Quantity. | Yield per ton of rock. | Quantity. | Yield. | |
| | *Fine ozs.* | *Pounds.* | *Pounds.* *Per ct.* | *Pounds.* | *Per ct.* | *Short tons.* |
| 1910 | 330,500 | 222,683,461 | 20.5 1.025 | 360,840,547 | 61.71 | 10,869,561 |
| 1911 | 497,281 | 219,840,201 | 20.0 1.000 | 338,908,309 | 64.86 | 10,978,827 |
| Increase (+) or decrease (−) | +166,781 | −2,843,260 | −0.5 −0.025 | −21,932,238 | +3.15 | +109,266 |

The following table shows the relative importance of the amygdaloid and the conglomerate rock in 1910 and 1911. As in previous years, the most significant fact brought out is the continued decrease in the copper derived from conglomerate. The relative proportion of conglomerate "rock" milled as compared with amygdaloid "rock" showed a slight decrease in 1911 from 1910. The copper derived from conglomerate dropped from 34.7 per cent in 1909 to 31.4 per cent in 1910 and to 30.0 per cent in 1911. The yield per ton of conglomerate "rock" was 28.7 pounds in 1909, 28.3 pounds in 1910, and 28.4 pounds in 1911.

In 1907 conglomerate "rock" produced 41.4 per cent of the output, with a yield of 33.9 pounds per ton.

In 1911 amygdaloid "rock" yielded 17.7 pounds of copper per ton as compared with 18.2 pounds per ton in 1910.

*Production of "rock" and "mineral" and yield in silver and copper in Michigan in 1910 and 1911 by kinds of rock.*

| | 1910 | | 1911 | |
|---|---|---|---|---|
| | Amygdaloid "rock." | Conglomerate "rock." | Amygdaloid "rock." | Conglomerate "rock." |
| Silver: | | | | |
| Fine ounces | 330,500 | | 497,281 | |
| Average yield per short ton of rock..ounce.. | 0.03 | | 0.04 | |
| Copper: | | | | |
| Pounds | 152,647,364 | 70,036,097 | 153,876,626 | 65,963,476 |
| Per cent of total | 68.6 | 31.4 | 70.0 | 30.0 |
| Average yield per short ton of rock..pounds.. | 18.2 | 28.3 | 17.7 | 28.4 |
| Average yield..per cent.. | 0.91 | 1.415 | 0.85 | 1.42 |
| "Mineral:" | | | | |
| Pounds | 221,969,487 | 138,871,060 | 224,308,354 | 114,599,955 |
| Per cent of total | 61.5 | 38.5 | 66.2 | 33.8 |
| Average yield in copper..per cent.. | 68.8 | 50.4 | 68.6 | 57.3 |
| "Rock:" | | | | |
| Short tons | 8,395,205 | 2,474,356 | 8,662,005 | 2,316,822 |
| Per cent of total | 77.2 | 22.8 | 79.7 | 20.3 |

Three counties, Houghton, Keweenaw, and Ontonagon, contributed to the output of copper and silver in 1911. The following table shows the relative importance of these counties in output of copper and silver for 1910 and 1911. It may be noted that the increase in

silver is not due to a marked increase in the silver content of the "rock," but that more copper was treated electrolytically in 1911 than in 1910. Houghton County shows a slight decrease in the recovery of copper per ton of "rock," owing to the continued decrease in the conglomerate rock. The recovery for the other counties was higher than in 1910, but the recovery for the entire district was slightly lower than in 1910; for 1911 it was almost exactly 20 pounds per ton, or 1 per cent.

*Production of silver and copper in Michigan for 1910 and 1191, by counties.*

1910.

| County. | Silver. | Copper. | | | "Mineral." | | "Rock." |
|---|---|---|---|---|---|---|---|
| | | Quantity. | Yield per ton of "rock." | | Quantity. | Yield. | |
| | *Fine oz.* | *Pounds.* | *Pounds.* | *Per cent.* | *Pounds.* | *Per cent.* | *Short tons.* |
| Houghton | 293,387 | 191,955,538 | 21.2 | 1.06 | 317,444,169 | 60.5 | 9,061,790 |
| Keweenaw | 37,113 | 27,923,424 | 17.7 | .88 | 39,189,881 | 71.2 | 1,580,026 |
| Ontonagon | ..... | 2,804,499 | 12.3 | .61 | 4,206,497 | 66.7 | 227,745 |
| Total | 330,500 | 222,683,461 | ..... | ..... | 360,840,547 | ..... | 10,869,561 |
| Average | ..... | ..... | 20.5 | 1.025 | ..... | 61.71 | ..... |

1911.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Houghton | 459,715 | 184,572,400 | 20.3 | 1.02 | 289,204,888 | 63.8 | 9,072,210 |
| Keweenaw | 37,053 | 32,079,885 | 18.8 | .94 | 45,225,456 | 70.9 | 1,704,048 |
| Ontonagon | 513 | 3,187,817 | 15.7 | .78 | 4,477,965 | 71.2 | 202,569 |
| Total | 497,281 | 219,840,201 | ..... | ..... | 338,908,309 | ..... | 10,978,827 |
| Average | ..... | ..... | 20.0 | 1.00 | ..... | 64.8 | ..... |

## REVIEW BY COUNTIES.

In the following reviews of the operations at the individual mines of the district during 1911, the statements concerning the quantity, character, and tenor of "rock" developed, the quantity of rock stamped, the copper recovered per short ton of rock stamped, and the cost of production are based on the published reports of the companies. In the few cases in which reports are not published a general statement of the character of operations is made from the best information available.

### HOUGHTON COUNTY.

In 1911 the mines of Houghton County produced 184,572,400 pounds of copper and 459,715 ounces of silver, or 83.9 per cent of the copper and 92.4 per cent of the silver output of Michigan. The county occupies the central portion of the copper belt and contains 16 of the 25 mines that contributed in 1911 to the copper output and 7 of the 10 mines that produced silver.

The details of the production in 1910 and 1911 are shown in the ollowing table:

*roduction of "rock" and "mineral" and average yield in silver and copper in Houghton County in 1910 and 1911 by kinds of rock.*

| | Amygdaloid rock. | | Conglomerate rock. | | Total and average. | |
|---|---|---|---|---|---|---|
| | 1910 | 1911 | 1910 | 1911 | 1910 | 1911 |
| lver: | | | | | | |
| Fine ounces | [a]293,387 | 459,715 | ..... | ..... | 293,387 | 459,715 |
| ppper: | | | | | | |
| Pounds | 121,919,441 | 118,608,924 | 70,036,097 | 65,963,476 | 191,955,538 | 184,572,400 |
| Per cent, county total | 63.5 | 64.3 | 36.5 | 35.7 | 100.0 | 100.0 |
| Average yield per ton of rock in pounds | 18.6 | 17.5 | 28.3 | 28.4 | 21.2 | 20.3 |
| Average yield....per cent.. | 0.93 | 0.87 | 1.41 | 1.42 | 1.06 | 1.02 |
| Mineral:" | | | | | | |
| Pounds | 178,573,109 | 174,604,933 | 138,871,060 | 114,599,955 | 317,444,169 | 289,204,888 |
| Average yield....per cent.. | 68.2 | 67.9 | 50.4 | 57.3 | 60.4 | 63.8 |
| Rock:" | | | | | | |
| Short tons | 6,587,434 | 6,755,388 | 2,474,356 | 2,316,822 | 9,061,790 | 9,072,210 |
| Per cent, county total | 72.7 | 74.5 | 27.3 | 25.5 | 100.0 | 100.0 |

[a] Silver from conglomerate and from amygdaloid rock has not been separated. A large percentage, however, was derived from amygdaloid rock.

The county shows a decrease of 7,383,138 pounds of copper and an ncrease of 166,328 fine ounces of silver. This increase in silver, as lready stated, is due to an increase in the quantity of copper that as refined electrolytically, rather than to any marked change in lver content of the "rock."

*Calumet & Hecla.*—The Calumet & Hecla mine has been one of the ost successful copper mines in the world. In the yield of copper and ividends paid it ranks first among the copper mines of the country. o the close of 1911 the company had distributed $115,850,000 in ividends.

The company's ground contains three copper-bearing lodes, the Calumet" conglomerate, the Osceola amygdaloid, and the "Kearrge" amygdaloid. A large percentage of the production in the past as come from the conglomerate lode, but with the decrease in copper ontent of this lode and its approaching exhaustion the mining from ie amygdaloid lodes has increased.

The company's annual report showing the details of operation for 911 is not yet available.

During 1910 there were 2,795,514 short tons of rock stamped, yieldng 72,059,545 pounds of copper, or an average of 25.77 pounds of ppper per ton of "rock." This compares with a yield of 28.18 ounds for 1909 and of 31.22 pounds for 1908. The total cost per ound of copper was 8.96 cents for 1910, as compared with 8.28 cents or 1909 and with 9 cents for 1908.

The conglomerate is opened for a distance of nearly 2 miles along s strike by 10 inclined and 1 vertical shaft. The inclined shafts ary in depth on the dip of the lode from 6,000 to 8,000 feet. The ed Jacket vertical shaft has a depth of 4,900 feet. The lode in the Five Forties" tract, extending north from the company's main oldings, is developed by a slope shaft from the fifty-seventh level. he rock from this shaft is hoisted to the surface through the Red acket shaft.

In 1910 the conglomerate lode produced 1,950,040 tons of "rock," yielding 58,739,509 pounds of copper, or an average of 30.12 pounds per ton of rock. This compares with 33.14 pounds for 1909, and with 35.96 pounds for 1908.

The cost of producing copper from the conglomerate lode in 1910 was 8.55 cents per pound, as compared with 7.77 cents in 1909 and with 8.38 cents in 1908.

The Osceola lode is developed by 6 shafts varying in depth from 1,234 to 3,232 feet. The lode has an average width of from 30 to 35 feet, though at some points it is much wider. The mineralization is confined principally to the hanging and the foot walls. The lode is opened by drift stopes along the hanging wall, where the mineralization is rather uniform. Crosscuts are extended to the footwall, where the mineralization is far less regular. During 1910 this lode produced 831,194 tons of "rock," yielding 13,150,427 pounds of copper, or 15.82 pounds per ton of "rock." This compares with a yield of 16.40 pounds for 1909 and of 17.67 pounds for 1908. The average cost per pound of copper from this lode for 1910 was 10.53 cents, as compared with 10.41 cents for 1909 and with 12.25 cents for 1908.

The Kearsarge lode is opened by 3 shafts, varying in depth from 1,350 to 2,164 feet. Development on this lode in Calumet & Hecla ground has not been encouraging, though the lode has proved very productive farther north. During the year 1910, 14,280 tons of "rock" from this lode yielded 169,609 pounds of copper.

*Tamarack.*—The Tamarack ground lies northwest of the Calumet & Hecla, and its operations are conducted on the underlays of the "Calumet" conglomerate and the Osceola amygdaloid. Both lodes enter the property at considerable depth and are reached by vertical shafts, the different levels being connected with these shafts by crosscuts. The property is opened by five shafts, varying in depth from 3,409 feet (No. 1) to 5,281 feet (No. 5), the latter having the distinction of being the deepest shaft in the world.

The company, although at a disadvantage on account of the great depth of the mine and the consequent high mining costs, has made a good record in dividends, which from 1888 to 1907 aggregated $9,420,000. Since the decline in the price of copper in 1907, however, the company has been unable to show a profit, and the cost of production must be materially reduced before dividends can be earned at the prevailing price of copper for recent years.

The average cost per pound of production during the last three years has been 14.30 cents for 1909, 14.70 cents for 1910, and 15.56 cents for 1911, resulting in a net loss for each year. In November, 1911, the company abandoned all openings, and for the last two months of the year the cost of producing copper was about 12 cents per pound.

Shaft No. 1 is used for handling the water in the southern portion of the mine, thus leaving the neighboring shafts free for the hoisting of ore. During the year approximately 30,000,000 gallons of water per month were raised through this shaft.

At No. 2 shaft stoping has been continued on in the conglomerate lode and the grade of rock is substantially the same as for 1910.

At No. 3 shaft the openings showed rock of fair grade; but, taken as a whole, they do not point to an improvement in value in depth or to the south, and they are poor to the north.

At No. 5 shaft the openings made during the year do not show values that are encouraging for the future.

During the year 392,338 tons of "rock" were stamped, yielding 12,793,430 pounds of "mineral" or 7,494,077 pounds of copper, or 19.1 pounds of refined copper per ton of "rock" stamped. This compares with a yield of 21.1 pounds in 1910 and 19.6 pounds in 1909.

*Osceola.*—During 1911 the Osceola Co. operated the three branches—the Osceola, the South Kearsarge, and the North Kearsarge. Since 1878 this company has distributed dividends to the amount of $10,016,300.

The Osceola lies directly south of the Calumet & Hecla and is worked on the Osceola amygdaloid. The property contains the Calumet & Hecla lode, but the only portion of this in Osceola ground that has been shown to carry copper in paying quantities was worked out in the early days of the mine. The reserves of copper-bearing ground are large, but the cost of production is higher than for either of the other branches. The construction and repair work in process at this branch were completed during the year, but no opening was accomplished.

The North Kearsarge lies north of the Wolverine and is worked on the Kearsarge lode. No. 1 shaft has a depth of 3,873 feet, No. 3 shaft has a depth of 3,192 feet, and No. 4 shaft has a depth of 1,449 feet. A total of 5,518 feet of opening was accomplished on this branch during the year. The openings contiguous to Nos. 1 and 3 have been under average. The thirteenth-level drift, the only opening to the south of No. 4 shaft, was in average ground. The drifts north, with the exception of the thirteenth and fourteenth levels, have been below average.

The South Kearsarge lies south of the Wolverine and east of the Centennial on the Kearsarge lode. No. 1 shaft has a depth of 2,820 feet and No. 2 shaft has a depth of 1,992 feet. During the year a total of 1,222 feet of opening was accomplished. The ground in this branch is practically developed, and at the present rate of production will be worked out in four or five years. The copper content of the rock was 18.22 pounds per ton in 1911, as compared with 18 pounds for 1910.

In 1911 the company stamped 1,246,596 tons of "rock," producing 24,452,912 pounds of "mineral," or 18,388,193 pounds of copper, an average yield of 14.8 pounds of refined copper per ton of "rock." This compares with a yield of 15.9 pounds in 1910, of 16.9 pounds per ton for 1909, and of 17.1 pounds per ton for 1908. The total cost of refined copper per pound was 9.28 cents for 1911, as compared with 9.37 cents in 1910, 9.47 cents for 1909, and with 10.25 cents for 1908.

The remodeling of two heads of the stamp mill was completed during the year. The new equipment consists of Woodbury classifiers and jigs, Wilfley tables, and Hardinge mills. This equipment makes possible an extraction of about 79 per cent, as compared with about 73 per cent with the old equipment. The added cost of treatment is about 1 cent per ton.

*Centennial.*—The Centennial ground lies north of the Calumet & Hecla and west of the South Kearsarge and the Wolverine. It contains the Calumet & Hecla, the Osceola, and the Kearsarge lodes, the

last being the only one of proved value in the property, and to this lode operations are at present confined.

At the close of 1910 the depth of No. 1 shaft was 3,821 feet. Work at this shaft was not resumed during 1911. Shaft No. 2 had a depth of 3,955 feet at the close of the year. A total of 2,639 feet of development was accomplished at this shaft. The openings to the north showed better ground throughout the year, especially on the lower drifts.

"Rock" to the amount of 86,543 tons was stamped during the year, producing 2,321,200 pounds of "mineral" and 1,493,834 pounds of refined copper, or 17.26 pounds refined copper per ton of rock stamped. The average cost of refined copper per pound was 12.69 cents as compared with 14.48 cents for 1910.

*Wolverine.*—The Wolverine is located between the North and the South Kearsarge branches of the Osceola Co. Its operations are on the "Kearsarge" amygdaloid, though the West lode, parallel with the Kearsarge lode and about 80 feet to the west, has been opened to a small extent. The mine has the distinction of having the richest amygdaloid, and, next to the "Calumet" conglomerate, the richest rock mined in the district. The lode is opened by four shafts, numbered from 1 to 4 from north to south. No. 1 is abandoned; No. 2, bottomed at the boundary at a depth of 1,700 feet, is used for handling men and supplies; No. 3 is below the twenty-fifth level and can be sunk to a depth of 4,300 feet before reaching the boundary; No. 4 was sunk below the thirty-third level during 1910. The lode in the Wolverine ground shows great uniformity of mineralization and is opened for the full length. In the upper levels the rock averaged from 16 to 18 pounds per ton, but as the lower levels were opened it showed marked improvement, the average for the fiscal year ending June 30, 1911, being 24.75 pounds per ton. The mine has ore blocked out well ahead of stoping requirements and at the present rate an assured output for some years to come. A crosscut has been extended east on the twenty-eighth level to explore the footwall of the Kearsarge lode, but at a distance of 400 feet had cut nothing worthy of examination.

The company's annual report showing the detailed operations in 1911 is not yet available.

During the fiscal year ending June 30, 1911, the mill at Traverse Bay stamped 388,476 tons of rock, yielding 12,227,500 pounds of "mineral," or 9,617,168 pounds of fine copper, or 24.75 pounds of fine copper per ton of "rock" stamped. The average cost of copper for this period was 7.54 cents per pound, a lower cost than for any other copper mine in the district.

*Franklin.*—The Franklin and the Rhode Island, which is controlled by the Franklin, are located southeast of the La Salle. The property carries several lodes, but in the past exploration has been principally on the "Pewabic" amygdaloid and the Allouez or "Albany and Boston" conglomerate. During 1911, operations were confined to the Pewabic lode.

The underground operations for 1911 were principally on levels 23 to 32, where 3,599 feet of drifting developed ground that compares favorably with that developed during 1910.

The surface plant at the mine was greatly improved and the mill remodeled, with a view to an increased production in 1912.

*Quincy.*—The Quincy mine is situated just north of the east-west arm of Portage Lake. The property is traversed by most of the lodes of the district, but has derived its principal output in the past from the Pewabic lode, with a small quantity from the West lode. During 1910 the company acquired 800 acres of land adjoining the property on the northwest and carrying the extension of the Pewabic lode.

The total length of opening in No. 7 shaft was upward of three-quarters of a mile in ground whose copper content shows no change. At No. 2 shaft, about 1½ miles of opening showed well in copper. At No. 6 shaft, more than 1¾ miles of opening showed well in copper. No. 8 shaft, with nearly 1½ miles of new openings, has developed to the north some of the heaviest copper ground of recent years. No. 9 shaft was sunk about 600 feet in 1911, to a point just below the 1,800-foot level, passing through some good copper rock.

Dividends from earnings during 1911 to the amount of $440,000 have been paid. The total disbursement of dividends from 1862 to 1911 has been $19,880,000.

During the year 1,382,524 tons of rock were stamped at the mills, and 32,550,440 pounds of mineral yielded 22,252,943 pounds of refined copper.

*Isle Royale.*—The Isle Royale mine is situated south of the east-west arm of Portage Lake, near Houghton. The property contains several copper-bearing lodes, of which the Isle Royale is the main producer at present. Development during the year consisted of 897 feet of sinking and 15,366 feet of drifting, drift stoping, and crosscutting. The Isle Royale lode is opened by four shafts, having depths at the close of 1911 as follows: No. 2, 3,162 feet; No. 4, 1,517 feet; No. 5, 1,006 feet; No. 6, 1,234 feet; "A" shaft, 972 feet. At No. 2 shaft the openings and stopes have not been up to the average quality of ground mined from this shaft during 1910, with the possible exception of the twenty-eighth level south. At No. 4 shaft developments and stopes showed rock quite up to the average for 1910. At No. 5 shaft openings were not quite so good as for 1910, but the stopes have shown rather better ground. Openings at No. 6 shaft were rather above the average; stoping ground showed little change from the preceding year. Work in the "A" shaft was discontinued in September, the openings not having been encouraging.

During the year 457,440 tons of "rock" were stamped, producing 10,339,171 pounds of "mineral," yielding 7,490,120 pounds of copper, or 16.4 pounds of refined copper per ton of "rock" stamped. The total cost per pound of refined copper was 10.85 cents.

In 1910 a total of 520,860 tons of "rock" stamped produced 10,433,060 pounds of "mineral," yielding 7,567,399 pounds of copper, or 14.5 pounds of refined copper per ton of "rock" stamped. The total cost per pound of refined copper in 1910 was 11.84 cents.

*Baltic, Champion, and Trimountain.*—These three mines are located on the Baltic lode southwest of Houghton and are under the same management, that of the Copper Range Consolidated Co. The Baltic is an exceptionally strong lode, having a stoping width varying from 15 to 80 feet. The lode has produced considerable "mass" copper and also contains veinlets of copper minerals, including chalcocite, bornite, and copper arsenides. These minerals are

recovered in the mill, and the arsenides probably account in part for the arsenical character of the copper range output.

During 1911 the Baltic operated four shafts, varying in depth from 1,624 to 2,380 feet at the close of the year. A total of 9,923 feet of drifting and 589 feet of crosscutting was accomplished during 1911. The new ground opened under No. 3 shaft and south of it continued poor, though there were indications of improvement; that opened under and north of No. 4 shaft was very good ground. A total of 696,795 tons of "rock" was stamped, producing 25,254,160 pounds of "mineral," yielding 15,370,449 pounds of refined copper, or 22.06 pounds of refined copper per ton of "rock" stamped. The cost per pound of refined copper was 9.09 cents.

The Trimountain is also opened by four shafts, with depths varying from 1,806 to 2,653 at the close of 1911. A total of 7,842 drifting and 344 feet of crosscutting was accomplished. The main production for the year was from No. 4 shaft.

The openings in the lower levels of No. 2 and No. 3 shafts showed a continuation of the improvement noted in 1910.

A total of 347,885 tons of "rock" was stamped, producing 10,705,685 pounds of "mineral," or 6,120,417 pounds of refined copper, a yield of 17.59 pounds of refined copper per ton of "rock" stamped. The cost per pound of copper was 11.55 cents. The company showed a profit of $60,370 for the year as compared with a profit of $32,250 for 1910.

The Champion, controlled jointly by the Copper Range Consolidated Co. and the St. Marys Mineral Land Co., like the two mines just described, is opened by four shafts, with depths varying from 1,972 to 2,328 feet at the close of 1911. A total of 9,746 feet of drifting and 1,334 feet of crosscutting was accomplished.

A total of 734,392 tons of "rock" was stamped, yielding 26,137,007 pounds of "mineral," or 15,639,426 pounds of refined copper, a yield of 21.296 pounds per ton of "rock" stamped. The cost of refined copper per pound was 9.63 cents.

*Atlantic.*—In July, 1911, the Atlantic was taken over by the Copper Range Consolidated Co. and is now operated under that management. No mining work was done after the Copper Range Consolidated Co. assumed control, but the railroad and mill were utilized in handling Superior rock.

*Superior.*—The Superior is located northeast of the Baltic on the Baltic lode. The lode on this property is being opened by two shafts. At the close of 1911 No. 1 shaft had reached a depth of 1,763 feet and No. 2 a depth of 1,210 feet.

The drifts south from No. 1 shaft have not shown rock of commercial value except on the fourteenth and fifteenth levels. On the north side of the shaft down to the ninth level no rock containing copper in commercial quantity has been developed north of the first fault. From the ninth level to the fourteenth level some good ground has been found north of this fault, but none has yet been found beyond a second fault, which is about 500 feet north of the first one.

Explorations by diamond drilling and crosscuts in the hanging wall of the Superior lode on the twelfth, thirteenth, and fourteenth levels have developed what appears to be a new copper-bearing amygdaloid lode lying parallel with the Superior and separated from it by a bed of trap varying in thickness from 1 to 45 feet.

The lode has been found to be well charged with copper and to vary in thickness from 14 to 30 feet.

But little copper ground was developed in the openings at No. 2 shaft.

During the year 162,599 tons of "rock" were stamped, producing 3,236,233 pounds of copper, or 19.90 pounds per ton of "rock" stamped. The cost of copper per pound was 15.31 cents.

*La Salle.*—Development was continued at the La Salle mine and some test shipments of rock were made.

At No. 1 shaft developments have shown ground of about average quality, with a tendency to improve in the lower openings to the south, as compared with the upper levels in that side of the shaft. At No. 2 shaft developments to the north have improved materially and have shown some fair copper values. These values have not shown in the rock to the south.

During the year 18,970 tons of "rock" were stamped, yielding 280,598 pounds of refined copper, or an average of 14.77 pounds per ton of "rock" stamped.

*Hancock.*—Development continued at the Hancock mine during 1911. At No. 1 shaft the principal development work was confined to No. 3 vein at the twelfth, thirteenth, fourteenth, fifteenth, sixteenth, and eighteenth levels.

Early in 1911 shipments of "rock" were begun to the Allouez-Centennial mill. It is reported that to June 1 the "rock" stamped had yielded an average of 19.27 pounds of copper per ton.

At No. 1 shaft considerable stoping was done on Nos. 2 and 3 veins from the ninth to the eighteenth levels. A stamp-mill test of this "rock" resulted as follows: Tons stamped, 41,449; refined copper produced, 754,749 pounds, or 18.21 pounds of copper per ton of "rock" stamped.

No. 2 shaft was sunk to a depth of 3,197 feet. At a depth of 3,105 feet an amygdaloid lode was intersected heavily charged with copper. The thickness at the point of intersection was between 7 and 8 feet.

The permanent surface plant was placed in commission early in the year.

*Houghton.*—The Houghton ground lies between the Isle Royale and section 16 of the Atlantic and is developing what is supposed to be the Baltic lode. During 1911 the shaft was sunk to a depth of 623 feet. Crosscuts were extended to the lode at depths of 450 feet and 620 feet, and a limited amount of exploration developed ground of encouraging character. At the 620-foot level the lode was found considerably faulted and broken.

*Wyandot.*—At the Wyandot, operations were continued in exploratory shaft No. 11, the crosscut to the east being advanced to a distance of 1,689 feet from the shaft. No new copper-bearing lodes were encountered in this work. Diamond drilling, trenching, and shallow shafts with crosscuts disclosed several lodes carrying encouraging amounts of copper.

*Winona.*—During 1911 the Winona Copper Co. absorbed the King Phillip Copper Co. The company entered the producing list in March, when one head of the stamp mill was placed in operation. During the remainder of the year 97,445 tons of "rock" were stamped, yielding 2,533,870 pounds of mineral and 1,275,675 pounds

of refined copper, an average of 13.09 pounds of refined copper per ton of "rock."

*Mayflower.*—Diamond-drill exploration was continued at the Mayflower, and a mineralized zone of much promise was encountered in holes Nos. 16 and 17, about 900 or 1,000 feet below the "St. Louis" conglomerate. In No. 17 hole, an average assay for 72 feet gave 1.33 per cent copper. This appears to be one of the most important discoveries of the year in the district.

*Old Colony.*—Diamond drilling exploration was carried on at the Old Colony during the year. Holes Nos. 8 and 11 disclosed mineralized ground carrying some copper.

*St. Louis.*—At the St. Louis diamond drilling was continued and an amygdaloid lode, called the St. Louis lode, was cut by several holes. In some of these it carried encouraging amounts of copper.

*Oneco.*—During the year the shaft was sunk to a depth of 1,014 feet. It is reported that recent developments on the ninth level have been encouraging.

*New Baltic.*—A shaft was started on this property which had reached a depth of about 200 feet at the close of 1911.

*New Arcadian.*—Diamond drilling and some pit work and trenching at the New Arcadian disclosed some lodes that seem worthy of further development.

### KEWEENAW COUNTY.

In 1911 Keweenaw County produced 32,079,885 pounds of copper and 37,053 fine ounces of silver, being 14.6 per cent of the copper and 7.4 per cent of the silver produced in the Lake district. The county occupies the northern part of the Keweenaw Peninsula and contains the northern portion of the copper belt. This section of the belt produced considerable copper in the early days of Lake mining, but of late years has furnished a comparatively small percentage of the total output. Developments, however, indicate that the county should increase in importance in the future.

The following table shows the production of "rock" and "mineral" and the average yield in silver and copper in Keweenaw County for 1910 and 1911:

*Production of "rock" and "mineral" and average yield in silver and copper in Keweenaw County in 1910 and 1911.*

| Year. | Silver. | Copper. | | | "Mineral." | | "Rock." |
|---|---|---|---|---|---|---|---|
| | | Quantity. | Yield per ton of "rock." | | Quantity. | Yield. | |
| | *Fine ozs.* | *Pounds.* | *Pounds.* | *Per cent.* | *Pounds.* | *Per cent.* | *Short tons.* |
| 1910 | 37,113 | 27,923,424 | 17.7 | 0.88 | 39,189,881 | 71.2 | 1,580,026 |
| 1911 | 37,053 | 32,079,885 | 18.8 | .94 | 45,225,456 | 70.9 | 1,704,048 |

From this table it is seen that in 1911 there was an increase in the quantity of "rock" treated, and also an increase in the quantity of copper recovered per ton of "rock."

*Allouez.*—The Allouez mine is north of the North Kearsarge and, as in recent years, has confined its operations to the Kearsarge lode.

As this lode does not outcrop on Allouez property, the shafts were started in the hanging wall at a steep angle and flattened to the dip of the copper-bearing bed just before reaching it. This plan avoids the expense of long crosscuts necessitated by vertical shafts. At the end of 1911 No. 1 shaft had a depth of 3,298 feet. A total of 3,926 feet of opening was accomplished at this shaft during the year. Openings to the north and south were of average quality, but shafts sinking showed only fair values. No. 2 shaft had a depth of 3,228 feet, and 3,303 feet of opening was accomplished. The development at No. 2 shaft warranted greater hoisting capacity and the installation of the necessary machinery was started in July.

A total of 388,610 tons of "rock" was stamped during the year, yielding 7,532,490 pounds of "mineral," or 4,780,494 pounds of refined copper, or 16.56 pounds of refined copper per ton of "rock." The total cost per pound of refined copper was 13.3 cents.

*Ahmeek.*—The Ahmeek mine, lying north and east of the Allouez, is located on the Kearsarge lode. The lode is opened by four shafts. No. 1 has a depth of 2,281 feet. A total of 4,366 feet of openings was accomplished at this shaft. The openings to the north show ground of average quality. To the south, the ninth to thirteenth levels are poor, but the fourteenth, fifteenth, and sixteenth levels show average ground.

No. 2 shaft had a depth of 2,410 feet at the close of 1911. A total of 4,494 feet of drifting disclosed ground of average grade, with the exception of the eleventh, twelfth, and thirteenth levels to the north, which showed richer ground. No. 3 shaft had a depth of 1,683 feet and No. 4 of 1,687 feet at the close of 1911. At No. 3 shaft 1,416 feet of drifting was accomplished and at No. 4, 1,346 feet. At Nos. 3 and 4 the developments show a lower average grade of "rock" than at Nos. 1 and 2.

A total of 598,549 tons of "rock" was stamped, yielding 21,917,925 pounds of "mineral" and 15,196,127 pounds of refined copper, or 25.4 pounds of refined copper per ton of "rock." The total cost per pound of refined copper was 7.17 cents.

Two dividends, amounting to $250,000, were declared during the year.

*Mohawk.*—The Mohawk mine, lying east of the Ahmeek, carries the outcrop of the Kearsarge lode for more than a mile, and also contains several cross fissures carrying arsenides of copper, which have been mined to considerable extent in the past. Operations were conducted through five shafts. No. 1 is below the twenty-first level; No. 2 below the twentieth level; No. 4 below the eighteenth level; No. 5 below the thirteenth level; and No. 6 is below the ninth level. A total of 14,428 feet of drifting during the year developed ground of good grade. A total of 802,548 tons of "rock" was stamped, yielding 15,760,700 pounds of "mineral," or 12,091,056 pounds of copper, a yield of 15.07 pounds of refined copper per ton of "rock" stamped. The total cost of refined copper per pound for the year was 10.14 cents.

*Gratiot.*—The Gratiot is developed in the Kearsarge lodge. But little development was accomplished during the year, the property being closed down March 31, 1911.

"Rock" to the amount of 1,347 tons was stamped, yielding 14,275 pounds of copper, or 10.6 pounds of copper per ton of "rock" stamped.

*Seneca.*—At the Seneca there was some development of the Kearsarge lode, but little was accomplished during the year, work at the No. 1 shaft being stopped in April.

*Ojibway.*—Some production was made from this property late in 1911, and the mill test of the ground developed was continued in 1912.

*Cliff.*—At the Cliff property the vertical shaft was sunk to a depth of 217 feet. At 205 feet drifts were started in the lode, but at the close of the year had not disclosed copper ground.

*Keweenaw.*—At the Keweenaw property shaft No. 2 in the Kearsarge lode was sunk to depth of 1,355 feet, with such unfavorable results that it was decided to dismantle it.

*Arnold.*—A small amount of mass copper was produced from the "Arnold" ash bed.

### ONTONAGON COUNTY.

In 1911 Ontonagon County produced 3,187,817 pounds, or 1.4 per cent of the copper produced in the Lake district, and 513 ounces of silver. Ontonagon County contains the southwestern portion of the copper belt. This portion has not been so thoroughly developed, and consequently the geology is less understood than in the more northern counties. So far as developed, the lodes are more bunchy than to the north and have produced a relatively high percentage of mass copper. The production of 1911 was derived wholly from amygdaloid rock.

The following table shows the production of the county for 1910 and 1911:

*Production of "rock" and "mineral" and average yield in silver and copper of Ontonagon County in 1910 and 1911.*

| Year. | Silver. | Copper. | | | "Mineral." | | "Rock." |
|---|---|---|---|---|---|---|---|
| | | Quantity. | Yield per ton of "rock." | | Quantity. | Yield. | |
| | *Fine ozs.* | *Pounds.* | *Pounds.* | *Per cent.* | *Pounds.* | *Per cent.* | *Short tons.* |
| 1910 | ..... | 2,804,499 | 12.4 | 0.63 | 4,206,497 | 66.7 | 227,745 |
| 1911 | 513 | 3,187,817 | 15.7 | .78 | 4,477,965 | 71.2 | 202,569 |

The production for 1911 shows a slight increase over that of 1910. The developments in the county for the last few years have been very encouraging, and it will probably show an increase in production in the future.

*Adventure.*—Operations during the year were confined principally to the sinking of the shaft to cut the three lodes that were located by diamond drills during 1908 and 1909. At the close of 1911 the shaft had reached a depth of 1,500 feet. At 1,021 feet a crosscut was extended to No. 1 lode, and this was drifted on for 200 feet without encouraging results. From the bottom of the shaft a crosscut was started to explore lodes Nos. 2 and 3.

*Mass.*—The Mass mine, adjoining the Adventure on the southwest, carries six known copper-bearing amygdaloid lodes, the Knowlton,

the Mass, the North Butler, the Butler, the Ogima, and the Evergreen. In addition the position of the property makes it probable that the newly discovered lodes in this part of the district may be present in the Mass ground. The main developments for the year were from "B" and "C" shafts on the Butler and Evergreen lodes, and the results were very satisfactory.

During 1911 the property of the Evergreen Bluff Mining Co. was acquired. This will give the Mass Co. opportunity for additional development on the Evergreen lode.

During the year 99,362 tons of "rock" were stamped, yielding 1,949,720 pounds of "mineral," or 1,326,898 pounds of refined copper, a yield of 17.58 pounds of refined copper per ton of "rock" stamped.

*Michigan.*—The Michigan mine has three shafts on the Calico lode, with crosscuts reaching to the Branch lode and to other lodes of less importance. In recent years the production has been largely from the Calico and the Branch lodes, though other lodes have contributed in the past. The mine has been a famous producer of "mass" copper, and the Branch lode, though narrow, is one of the richest lodes of the district.

The Calico lode is from 5 to 25 feet wide in the upper workings, but narrows to 4 or 6 feet at the 2,000-foot level. In the upper workings the copper occurs as a pay streak on the footwall, with patches of good ground on the hanging wall and in the center of the lode.

Only diamond-drill exploration was carried on at this property during the year, and this was discontinued in March, 1911.

*Victoria.*—The Victoria is the most southwesterly of the Lake mines that have made important production. The first attempts at copper mining in the district are said to have been made at this locality, though its recent period of productiveness began in 1906. The present production is from the Forest lode. The old No. 2 shaft, through which present operations are carried on, is bottomed at the twenty-second level. Operations for the year were conducted on levels between the fourth and the twenty-second levels, a total of 2,831 feet of drifting resulting in the development of copper ground of exceptionally good grade at several points. The new No. 6 shaft was sunk to a depth of 827 feet. A total of 126,894 tons of "rock" was stamped, producing 2,128,245 pounds of "mineral."

*Lake.*—The new Lake shaft was completed below the eighth level, and the permanent hoisting equipment was nearly completed at the close of the year.

The mine made no production during 1911, but will again enter the producing list in 1912.

*North Lake.*—Diamond drilling was continued at the North Lake, and further information concerning the structure and some promising cores were obtained. At the close of 1911 plans were in progress for sinking a vertical shaft to explore the lodes encountered by the diamond drill.

*Indiana.*—At the Indiana property No. 1 vertical shaft was sunk to a depth of 533 feet. This shaft is being put down to explore the promising deposit encountered in No. 2 drill hole.

*Algomah.*—Exploration was continued throughout 1911 with a view to gathering data on the structure. Still further data will be necessary for a clear understanding of the structural problems.

*South Lake.*—A shaft was located for exploring the copper-bearing lodes exposed by diamond drilling, but was later abandoned on account of the excessive amount of water encountered. A new location had not been chosen at the close of 1911.

## MISSOURI.

By J. P. Dunlop.

### PRODUCTION.

#### SILVER.

The following table shows the production of silver in Missouri in the years 1907 to 1911, inclusive:

*Production of silver in Missouri, 1907–1911.*

| Year. | Silver. | | Lead concentrates, silver-bearing. |
|---|---|---|---|
| | Quantity. | Value. | |
| | *Fine ounces.* | | *Short tons.* |
| 1907 | 25,692 | $16,957 | ..... |
| 1908 | 49,131 | 26,039 | 26,488 |
| 1909 | 14,188 | 7,378 | 31,000 |
| 1910 | 33,096 | 17,872 | 35,002 |
| 1911 | 49,867 | 26,430 | 51,109 |

The quantities given in the first column of the foregoing table are those of recovered silver. The silver content of the ores is so small that it is disregarded in the assay and sale of the concentrates. For this reason the smelter reports must be relied upon for the silver production. As may be seen by inspection of the table, the quantity of silver produced in any year bears no direct ratio to the quantity of concentrates smelted during that year. The reason for this is that the silver content is so small in quantity that the silver bullion is stored and refined in batches. If a series of years be taken into account, the concentrates are seen to average about 1 ounce of silver to the ton. The value is estimated at the average New York price according to the United States Mint.

#### COPPER.

The production of copper in Missouri in 1911 was 640,411 pounds, valued at $80,051, as compared with 94,452 pounds, valued at $11,955, in 1910. The mines of the North American Lead Co., which produced some copper as well as nickel and cobalt in the years 1908 and 1909, were idle during 1910 and 1911. The copper output for both 1910 and 1911 was derived from concentrates recovered in dressing lead ore mined in St. Francois County, in southeast Missouri.

## LEAD AND ZINC.

The production of lead and zinc in Missouri in 1911 is shown in the following table:

*Production of lead and zinc in Missouri in 1911, by districts, in short tons.*[a]

| District. | Ore. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Lead concentrates. | | | | Zinc concentrates. | | | |
| | Galena. | | Carbonate. | | Sphalerite. | | Silicate and carbonate. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Southwest Missouri: | | | | | | | | |
| Alba-Neck City | 328 | $19,508 | ..... | ..... | 15,995 | $707,537 | ..... | ..... |
| Ash Grove-Everton | 51 | 2,646 | ..... | ..... | ..... | ..... | 125 | $2,100 |
| Aurora | 84 | 4,076 | 24 | $962 | 3,273 | 122,608 | 1,829 | 37,239 |
| Carl Junction | 69 | 3,696 | ..... | ..... | 4,610 | 189,127 | ..... | ..... |
| Carthage | 100 | 5,500 | ..... | ..... | 2,471 | 98,382 | 221 | 4,882 |
| Cave Springs | 317 | 18,469 | ..... | ..... | 4,497 | 196,994 | ..... | ..... |
| Duenweg-Porto Rico | 2,397 | 133,201 | ..... | ..... | 16,550 | 649,829 | 2,552 | 65,860 |
| Granby | 623 | 33,824 | 43 | 1,636 | 4,330 | 152,662 | 9,405 | 239,194 |
| Joplin | 6,158 | 325,885 | 45 | 1,512 | 41,300 | 1,650,091 | 1,707 | 36,488 |
| Oronogo | 1,491 | 82,993 | ..... | ..... | 10,173 | 425,680 | ..... | ..... |
| Sarcoxie-Reeds | 8 | 400 | 6 | 180 | 1,836 | 70,627 | 990 | 21,447 |
| Sherwood-Thoms Station | 641 | 35,382 | ..... | ..... | 12,603 | 443,822 | ..... | ..... |
| Spring City-Beef Branch | 725 | 36,974 | 10 | 293 | 2,350 | 74,946 | 2,372 | 50,306 |
| Springfield | 230 | 12,203 | ..... | ..... | 900 | 38,006 | ..... | ..... |
| Spurgeon | 868 | 48,614 | 106 | 3,775 | 80 | 2,700 | 400 | 8,137 |
| Stotts City | 44 | 2,400 | ..... | ..... | 820 | 35,472 | ..... | ..... |
| Webb City-Carterville-Prosperity | 24,626 | 1,396,167 | ..... | ..... | 93,462 | 3,718,617 | ..... | ..... |
| Wentworth and Barry County[b] | ..... | ..... | ..... | ..... | 485 | 19,885 | 8 | 191 |
| Zincite | 101 | 5,564 | ..... | ..... | 1,964 | 79,584 | ..... | ..... |
| Total | 38,861 | 2,167,502 | 234 | 8,358 | 217,699 | 8,676,569 | 19,609 | 465,844 |
| Central and southeast Missouri | 219,145 | 10,293,400 | ..... | ..... | 113 | 3,990 | 510 | 11,576 |
| State, total: | | | | | | | | |
| 1911 | 258,006 | 12,460,902 | 234 | 8,358 | 217,812 | 8,680,559 | 20,119 | 477,420 |
| 1910 | 247,861 | 11,286,750 | 197 | 6,385 | 232,341 | 9,342,139 | 23,826 | 561,803 |
| 1909 | 249,151 | 10,893,024 | 385 | 11,124 | 229,023 | 9,445,826 | 28,525 | 677,213 |
| 1908 | 218,213 | 8,629,039 | 664 | 18,220 | 198,340 | 6,800,359 | 20,601 | 451,607 |
| 1907 | 193,528 | 10,535,890 | 357 | 11,764 | 222,347 | 9,208,465 | 18,733 | 427,146 |

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses in case of zinc, but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York and St. Louis.

[b] Includes small shipment of zinc silicate from Barry County.

*Production of lead and zinc in Missouri in 1911, by districts, in short tons*—Con.

| District. | Metal content. | | | |
|---|---|---|---|---|
| | Lead. | | Zinc. | |
| | Quantity. | Value. | Quantity. | Value. |
| Southwest Missouri: | | | | |
| Alba-Neck City | 262 | $23,580 | 8,826 | $1,006,164 |
| Ash Grove-Everton | 41 | 3,690 | 41 | 4,674 |
| Aurora | 79 | 7,110 | 2,344 | 267,216 |
| Carl Junction | 54 | 4,860 | 2,479 | 282,606 |
| Carthage | 80 | 7,200 | 1,353 | 154,242 |
| Cave Springs | 248 | 22,320 | 2,411 | 274,854 |
| Duenweg-Porto Rico | 1,896 | 170,640 | 9,695 | 1,105,230 |
| Granby | 523 | 47,070 | 5,693 | 649,002 |
| Joplin | 4,915 | 442,350 | 22,667 | 2,584,038 |
| Oronogo | 1,171 | 105,390 | 5,489 | 625,746 |
| Sarcoxie-Reeds | 9 | 810 | 1,326 | 151,164 |
| Sherwood-Thoms Station | 513 | 46,170 | 6,202 | 707,028 |
| Spring City-Beef Branch | 581 | 52,290 | 2,008 | 228,912 |
| Springfield | 184 | 16,560 | 514 | 58,596 |
| Spurgeon | 749 | 67,410 | 184 | 20,976 |
| Stotts City | 35 | 3,150 | 451 | 51,414 |
| Webb City-Carterville-Prosperity | 19,694 | 1,772,460 | 49,282 | 5,618,148 |
| Wentworth and Barry County [a] | ..... | ..... | 265 | 30,210 |
| Zincite | 80 | 7,200 | 1,052 | 119,928 |
| Total | 31,114 | 2,800,260 | 122,282 | 13,940,148 |
| Central and southeast Missouri | 147,754 | 13,297,860 | 233 | 26,562 |
| State, total: | | | | |
| 1911 | 178,868 | 16,098,120 | 122,515 | 13,966,710 |
| 1910 | 161,016 | 14,169,408 | 129,589 | 13,995,612 |
| 1909 | 159,435 | 13,711,410 | 130,162 | 14,057,496 |
| 1908 | 144,459 | 12,134,556 | 107,404 | 10,095,976 |
| 1907 | 138,675 | 14,699,550 | 116,752 | 13,776,736 |

[a] Includes small shipment of zinc silicate from Barry County.

The total value of the recoverable metallic content of the lead and zinc concentrates produced in Missouri in 1911 was $30,064,830, an increase of $1,899,810 over that for 1910. The production of lead concentrates in Missouri in 1911 (of which all but 234 tons were galena) was 258,240 short tons, valued at $12,469,260, as compared with an output of 248,058 tons, valued at $11,293,135, in 1910, an increase of 10,182 tons in quantity and of $1,176,125 in value. Of this 1911 production of lead concentrates 219,145 tons, valued at $10,293,400, was derived from southeast and central Missouri, an increase of 8,260 tons in quantity and of $933,091 in value. The average metal content of the lead concentrates from these districts was 67.3, as compared with 62.3 in 1910, and the value per ton in 1911 was $46.94, an increase of $2.59 per ton in 1911 over 1910. The quantity of recoverable lead in southeast and central Missouri concentrates in 1911 amounted to 147,754 tons, an increase of 16,255 tons. The output was equal to about 36 per cent of the primary lead smelted or refined from domestic ores in the United States in 1911.

Shipments of lead concentrates from southwest Missouri were 39,095 tons, valued at $2,175,860, as compared with 37,168 tons, valued at $1,932,826, in 1911. The lead carbonate concentrates amounted to only 234 tons, valued at $8,358, an increase of 37 tons. The average metal content of the galena concentrates from southwest Missouri was 79.7 per cent, and the average price per ton was $55.75, or $3.75 more per ton than in 1910. The quantity of zinc blende concentrates sold by Missouri mines in 1911 was 217,812 tons,

alued at $8,680,559, a decrease of 14,529 tons in quantity and of 661,580 in value when compared with the 1910 figures. All of the lende concentrate except 113 tons was produced in southwest Missouri. The average price received per ton was $39.86 and the verage recoverable zinc content was 58.7 per cent. The average rice paid per ton in 1910 was $40.21 and the average recoverable inc content was 59.2 per cent. The lessened output from sheet round mines and the marketing of some concentrates having a high ron content was the principal reason for the reduction in the recovrable zinc content. These conditions doubtless were also responsible or part of the reduction in the price paid.

The zinc carbonate and silicate concentrates sold in 1911 amounted o 20,119 tons, valued at $477,420. This was 3,707 tons less in quantity nd $84,383 less in value than the sales in 1910. The output in 1911 as almost entirely from southwest Missouri, the shipments from outheast Missouri being only 510 tons, valued at $11,576, as comared with 929 tons, valued at $19,000, in 1910. The average reoverable metal content of the zinc carbonate and silicate concenrates was 40.6 per cent in 1910 and 40.4 per cent in 1911. The verage value per ton in 1911 was $23.73, as compared with $23.58 n 1910.

The combined value of lead and zinc concentrates from the southast and central Missouri in 1911 (which produced about 85 per ent of the lead) was $10,308,966, or $929,657 more than in 1910. he total value of the southwest Missouri lead and zinc concentrates as $11,318,273, as compared with $11,817,768 in 1910.

In the following tables showing the tenor of crude ore ("dirt") and oncentrates from Missouri it has been considered advisable to segreate the ores of different nature. For instance, the disseminated lead re from southeast Missouri differs radically from the lead and zinc res from the so-called "soft-ground" deposits of southwest Missouri, nd these in turn differ from the "sheet-ground" deposits of the same egion. Each class of ore has its peculiar problems of mining and ore ressing. This fact makes desirable the separate treatment of the tatistical data. Generally speaking, the tables reflect very closely he conditions of the industry.

*enor of crude lead and zinc ore and concentrates produced in southwest Missouri, 1910–11.*[a]

| | 1910 | 1911 |
|---|---|---|
| "SOFT GROUND."[a] | | |
| otal crude ore, short tons | 3,275,705 | 3,217,166 |
| otal concentrates in crude ore, per cent | 4.4 | 4.5 |
| Lead, do | .4 | .4 |
| Zinc, do | 4.0 | 4.1 |
| etal content of crude ore, do | 2.5 | 2.6 |
| Lead, do | .3 | .3 |
| Zinc, do | 2.2 | 2.3 |
| verage lead content of galena concentrates, do | 79.2 | 79.9 |
| verage lead content of lead carbonate concentrates, do | 47.6 | 54.7 |
| verage zinc content of sphalerite concentrates, do | 59.1 | 58.9 |
| verage zinc content of silicates and carbonates, do | 35.9 | 40.4 |
| verage value per ton of galena concentrates | $51.06 | $54.41 |
| verage value per ton of lead carbonate concentrates | $32.41 | $35.72 |
| verage value per ton of sphalerite concentrates | $39.40 | $40.80 |
| verage value per ton of silicates and carbonates | $23.58 | $23.76 |

[a] Including also the small production of lead and zinc ores in central Missouri.

*Tenor of crude lead and zinc ore and concentrates produced in southwest Missouri, 1190–11*—Continued.

| | | 1910 | 1911 |
|---|---|---|---|
| "SHEET GROUND." | | | |
| Total crude ore | short tons | 5,779,192 | 4,944,910 |
| Total concentrates in crude ore | per cent | 2.6 | 2.6 |
| Lead | do | .4 | .5 |
| Zinc | do | 2.2 | 2.1 |
| Metal content of crude ore | do | 1.6 | 1.64 |
| Lead | do | .3 | .4 |
| Zinc | do | 1.3 | 1.24 |
| Average lead content of galena concentrates | do | 79.9 | 79.9 |
| Average zinc content of sphalerite concentrates | do | 59.3 | 58.6 |
| Average value per ton of galena concentrates | | $52.01 | $56.50 |
| Average value per ton of sphalerite concentrates | | $40.81 | $39.79 |

*Tenor of crude lead ore and concentrates in southeast Missouri disseminated lead ore, 1910–11.*

| | | 1910 | 1911 |
|---|---|---|---|
| Total crude lead ore | short tons | 3,693,523 | 3,974,712 |
| Galena concentrates in crude ore | per cent | 5.7 | 5.5 |
| Lead content in crude ore | do | 3.5 | 3.7 |
| Average lead content of galena concentrates | do | 62.3 | 67.3 |
| Average value per ton of galena concentrates | | $44.35 | $46.94 |

The main lead and zinc producing regions of Missouri are in the southwestern and southeastern parts of the State. The former is the greatest zinc-producing area in the United States. The latter contains the district of the disseminated lead ore, and in 1908, 1909, 1910, and 1911 exceeded in production the Cœur d'Alene region, which in recent years has held first rank in the United States. The central Missouri district has produced considerable ore in the past, but it is operated sporadically, and in 1910 and 1911 had so small a production that its output is included with that of southeast Missouri. The silver and copper production of the State is limited to the southeastern district.

## SOUTHWEST MISSOURI.

The southwest Missouri lead and zinc area includes the largest part of the Joplin region, the remaining portion lying in southeast Kansas and in northeast Oklahoma. The ore occurs in the Boone formation and in rocks of Kinderhook age, both belonging to the lower Carboniferous. The ore deposits are found in Jasper, Newton, Lawrence, Greene, and adjoining counties. This area produces about four-fifths of the lead and zinc ore raised in the Joplin region.

The lead ores are galena, with a small quantity of lead carbonate, locally known as "dry bone"; the zinc ores are sphalerite, or zinc blende, or "jack," zinc carbonate (smithsonite), and zinc silicate (calamine), both of the latter locally called "silicate." The galena contains but a small fraction of an ounce of silver to the ton of lead concentrates, and although ordinarily it is not desilverized, yet occasionally the refineries find it advantageous to add lead from the Joplin region to their charges, without, however, making any record of the silver content. In this way an unknown but small quantity of

ilver is recovered from southwest Missouri lead ore. The zinc ores, phalerite, smithsonite, and calamine contain notable quantities of admium, being fully as rich in this respect as the zinc ores of Silesia, which are the source of the cadmium production of Europe. The discussion of the cadmium content of these ores is taken up more fully in the chapter in Mineral Resources for 1908 entitled "Cadmium."

The ore deposits of the Joplin district vary in character with the depth of mining. The shallower ores beginning at the surface are universally pockety and are found in residual clays or in "runs" in the basal breccias of the region. The breccias and the forms of the "runs" are largely, if not altogether, due to solution of the limestone strata. One form of run which is fairly numerous is the "circle" deposit, which in the popular view has come to be nearly synonymous with rich deposits. Small veins, vertical sheets, and thin crevice deposits are often met with in prospecting, but unless they develop into stringers leading into paying ore bodies are forgotten in the multitude of rich pockety deposits which the district has yielded. The blanket deposits or "sheet ground" are found in the Grand Falls chert member of the Boone formation at depths varying from 125 to 175 feet, depending on the topography and the geologic structure. Below this horizon there are, in the rocks of Kinderhook age, deposits of disseminated ore. They have been struck in prospect shafts or drill holes near Springfield, Aurora, Granby, Carterville, Joplin, Hornet, and Cave Springs, in Missouri; at Galena, in Kansas; and at Quapaw, in Oklahoma.

### ORE PRODUCTION.

Mining and milling practice in the Joplin region is so well known through the numerous articles that have appeared in the mining press of the country that but few words are necessary here. The type of mill erected in the district is carefully chosen to fit the needs of the particular kind of ore body to be exploited, and being based on the evolutionary experience of nearly 40 years, is in general wisely selected.

In early days of zinc mining in the district when only the richest runs and pockets of the "disseminated" deposits could be profitably worked and the life of the individual mine was necessarily short, a very simple type of concentrating plant came into use. It was equipped with a rougher jig and a cleaner jig and had a capacity of 50 to 100 tons of crude ore per 10-hour shift. When a deposit was worked out the mill could be easily and cheaply moved to another deposit. When the increased price of concentrates made it possible to mine lower-grade ore and the life of the deposits was thereby lengthened, somewhat larger and more complete milling plants came into vogue. Sand jigs and concentrating tables were added to the equipment, and the capacity was raised to 200 or more tons per shift. Such mills, developed by the necessities of local conditions, came to be characterized throughout the lead and zinc regions of the Central States as the "Joplin type."

A further increase in the price of concentrates and the development of large bodies of low-grade "sheet-ground" deposits, insuring permanence and stability of operation and necessitating every refinement

of concentration, have resulted in the modern "sheet-ground mill" with capacity from 350 to 1,000 tons of crude ore per 10-hour shift, driven by steam, natural gas, or electricity, with complete equipment of ore-saving devices and with attendant economies of power, operation, and concentration.

### ORE SELLING.

As was noted in the introduction to this chapter, the lead and zinc ores of the Central States when marketed locally are sold on a plan which differs somewhat from the methods in vogue in the Western and other States where more complicated ores prevail. The producer is paid by the ton of concentrates, all ores being sold in that form. The price is arranged on a sliding scale, the foundation of which is the price paid for ores of a certain standard, namely, the "basis." In each of the ores a "basis" is arbitrarily taken which represents as nearly as may be the average metallic content of clean concentrate. In sphalerite or zinc blende concentrate the basis is 60 per cent (theoretical composition, 67 per cent) of metallic zinc, by wet assay or analysis; in the oxidized zinc ores, the carbonate and the silicate, the basis is 40 per cent (theoretical, 52 and 54 per cent) metallic zinc; and in galena concentrates the basis is 80 per cent (theoretical, 87 per cent) metallic lead. The buyer will offer so much for 60 per cent zinc ore which becomes the "base price." If the assay shows the concentrates to vary from the basis, $1 is added to the base price for each per cent of zinc above 60 and $1 subtracted for each per cent less than 60. Deduction is made for moisture, all concentrates being sold on dry, or net, weight. Penalties are exacted for the presence of undesirable elements, as iron, bitumen, barite, fluorspar, etc. One dollar is deducted for each per cent of iron above 1 per cent. The first ore sold from the new Miami district was penalized 2 "per cent"; that is, $2 was arbitrarily deducted for the bitumen clinging to the concentrates. The blende concentrates from Miami average about 50 per cent zinc and are penalized $10 per ton for falling 10 "per cent" below the "base," as well as an additional penalty for the iron contents. In practice, however, it has been found that these penalties are heavier than necessary and the ore buyers offset the excess by increasing the base offer over the base price obtaining in the other parts of the Joplin region where the concentrates average nearer 60 per cent. Fluorspar occurs in the zinc concentrates of western Kentucky and southern Illinois, but neither fluorite nor barite are found in quantity in the ores of the Central States except in some mines in central Missouri and in a single mine in the Joplin district. The practice of buying zinc blende concentrates on an assay basis became general in 1899, though it began in a small way a few years earlier. Formerly the ore was bought on "flat bid"—that is to say, the buyer made a visual inspection and mental estimate of the metallic contents and then offered so much per ton for the particular concentrates in question. An expert buyer can estimate the metallic contents very closely. Galena concentrates are generally bought on flat bid, though buying on assay is increasing. Ore which is sold in lump, such as hand-picked galena, lead carbonate, and carbonate and silicate of zinc, is very generally sold on flat bid.

ASSAYS.

Several of the assayers in the Joplin district make a practice of saving the remnants of blende samples analyzed during the year. At the close of the year the lot is thoroughly mixed and carefully sampled, from which sample an average or composite assay for the year is made. Each assay thus represents several thousand lots. Two representative series of such composite assays are given below. In most cases each sample included in the composite assay represents a carload lot of concentrates.

The first series, by W. W. Petraeus, of Joplin, gives the result of analyses of composite samples from the general district for the last 14 years. The analyses for 1897–1905, inclusive, were published in the Lead and Zinc News, volume 9, January 15, 1906, page 8. The analyses for 1906–1911, were kindly communicated by Mr. Petraeus. Iron was not taken into account until 1900. Some 400 scattering assays, made in 1895–96, are excluded from the table.

*Composite assays of zinc blende from the Joplin region, 1897–1911.*

[W. W. Petraeus, analyst.]

| Year. | Number of lots in the composite. | Percentage of zinc. | Percentage of iron. | Percentage of lead. | Percentage of copper. | Percentage of cadmium. |
|---|---|---|---|---|---|---|
| 1897 | 600 | 56.64 | | | | |
| 1898 | 1,299 | 56.99 | | | | |
| 1899 | 3,715 | 56.67 | | | | |
| 1900 | 3,500 | 57.36 | 0.22 | | | |
| 1901 | 3,683 | 57.53 | 2.02 | | | |
| 1902 | 5,776 | 57.08 | 2.24 | | | |
| 1903 | 6,014 | 57.30 | 2.00 | | | |
| 1904 | 6,220 | 57.24 | 2.10 | | | |
| 1905 | 4,628 | 57.97 | 1.84 | 1.00 | 0.001 | 0.198 |
| 1906 | 5,644 | 57.2 | 2.00 | | | |
| 1907 | 6,813 | 56.8 | 1.93 | | | |
| 1908 | 7,837 | 56.4 | 1.76 | | | |
| 1909 | 9,002 | 56.3 | 2.00 | | | |
| 1910 | 8,892 | 56.6 | 2.10 | 1.62 | .06 | .399 |
| 1911 | 8,920 | 57.1 | 2.40 | | | |

The next series of composite assays was communicated by Prof. W. George Waring, of Webb City. The original samples were of ores from the different camps of the district except where otherwise indicated. The methods used in making these assays have been published.[1]

[1] Waring, W. G., The volumetric determination of zinc: Jour. Am. Chem. Soc., vol. 26, No. 1, January, 1904. In addition to the composite assays for 1902 and 1903, shown in the table, the article gives the lead, copper, and cadmium content of a number of ores from individual mines in Missouri, Kentucky, and Illinois.

*Composite assays of zinc blende from the Joplin region, 1900-1911.*

[W. George Waring, analyst.]

| Year. | Number of lots in the composite. | Zinc. | Iron. | Lead. | Cadmium. | Copper. |
|---|---|---|---|---|---|---|
| | *Lots.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 1900 | 3,894 | 57.30 | 3.03 | | | |
| 1901 | 5,172 | 56.00 | 3.30 | | | |
| 1901 | 2,757 | 55.30 | 3.86 | | | |
| 1901 | [a] ±2,000 | 55.90 | 3.47 | | | |
| 1902 | 2,270 | 57.08 | 2.65 | 0.904 | 0.337 | 0.050 |
| 1903 | 2,145 | 57.75 | 2.32 | 1.072 | .388 | .049 |
| 1904 | [a] 3,800 | 58.26 | 2.23 | .701 | .304 | .049 |
| 1904 | [b] 2,691 | 58.46 | 1.97 | .720 | .430 | .050 |
| 1904 | 1,984 | 58.95 | 2.10 | | | |
| 1905 | 4,520 | 58.95 | 2.00 | | | |
| 1906 | 4,638 | 58.40 | 2.20 | | | |
| 1906 | 3.968 | 58.20 | 2.29 | | | |
| 1907-8 | ±4,000 | 58.70 | 2.00 | | | |
| 1909 | | [c] 57.40 | 2.60 | | | |
| 1910 | 6,377 | [c] 57.90 | 2.60 | | | |
| 1911 | 5,653 | 58.20 | 2.30 | | | |

[a] Joplin. [b] Webb City. [c] The composite sample included some lots of silicate ores.

The complete analysis of the composite sample of the 3,800 lots of concentrate from the Joplin district in 1904, sampled by C. V. Millar and analyzed by Waring, is as follows:

*Analysis of composite sample of zinc blende from the Joplin region.*

| | | | |
|---|---|---|---|
| Zinc | 58.26 | Calcium carbonate | 1.88 |
| Cadmium | .304 | Magnesium carbonate | .85 |
| Lead | .76 | Barium sulphate | .82 |
| Iron | 2.23 | Silica | 3.95 |
| Manganese | .01 | | |
| Copper | .049 | | 99.773 |
| Sulphur | 30.72 | | |

PRICES AND PRODUCTION.

The yearly average price received in 1911 by producers for sphalerite concentrates varied little from that received in 1910. Quoted base prices fell off badly in the spring months and were unstable until late in the year. The highest average quoted base prices for 60 per cent blende were in November and December and the lowest in March and April, ranging from $48 to $33 per ton. Calamine was highest in December and lowest in April, ranging from $29 to $18 per ton. Base prices for galena concentrates ranged from $64 in December to $53 in March. The average price of sphalerite or blende for 1911 was $39.86 as compared with $40.21 in 1910, and for zinc silicate or carbonate (calamine) concentrates it was $23.76 in 1911 and $23.58 in 1910. The average price paid for galena concentrates was $55.75, compared with $52 in 1910. The prices are not average base price quotations, but are the actual average prices calculated from the tonnage sold and the values reported to the United States Geological Survey by the sellers. It will be noted that while the average per cent of concentrates recovered from crude dirt showed little if any change, the average metal content of the blende concentrates was lower in ore mined on both "sheet" and "soft"

ground. There were some changes in the relative positions of the productive districts, an increase in some and a decline in others. Practically the entire decline in the yield of blende concentrates was due to lessened output from "sheet" ground operations. Ore prices were unfavorable (until too late in the year to affect production) for the extension of work involving large expenditures to obtain and concentrate large low-grade ore bodies. The estimated tonnage of ore mined from sheet ground declined from 5,779,192 tons in 1910 to 4,944,910 tons in 1911, and the output of concentrates from the "sheet" ground ore or dirt declined in proportion. It was remarkable that with continued low prices for such a long period the decline was not larger. The low prices, however, stimulated the prospecting for and development of rich ore in "soft" ground. Many of the new properties did not reach the producing stage in 1911, but some new "soft" ground mines made large outputs. The estimated yield of blende concentrates from sheet ground was slightly in excess of that from soft ground in 1910, but in 1911 the blende concentrates derived from "soft" ground mines exceeded that from the "sheet" ground mines by about 7,700 tons. The "sheet" ground properties yielded the most lead and the "soft" ground all of the lead carbonate and zinc carbonate and silicate. On the whole, the value of the concentrates from the mines working "soft" ground was very little more than the value of the concentrates derived from the "sheet" ground, although the tonnage of ore treated was much less.

The most important developments during 1911 were those in the Thoms Station, Carl Junction, Joplin, and Zincite camps, which are described under the district reviews.

Drilling operations were more active than for several years, and although the yield of zinc concentrates from the southwestern districts was less than it was in 1910, the work accomplished and the high ore prices prevailing in November and December, 1911, and continuing into 1912 indicate an increased production for 1912.

The Webb City-Carterville-Prosperity district, which includes many of the "sheet" ground mines, was again the largest producer of both blende and galena concentrates. It produced 63 per cent of the galena concentrates and 42 per cent of the sphalerite sold in southwest Missouri in 1911. In 1910 it produced over 61 per cent of the lead and 45 per cent of the sphalerite. The quantity of crude ore or "dirt" raised is a better indication of the extent of mining activity than the production of concentrates, for the "sheet ground" ore is of lower average tenor than "soft ground." The leading position of the district is more adequately shown by the fact that the estimated tonnage of ore mined in the Webb City-Prosperity district in 1911 was about 4,000,000 tons, very nearly half of the total tonnage of crude ore raised in southwest Missouri. Joplin, the second most productive district in 1911, showed a small increase in zinc silicate but considerably less zinc blende than in 1910.

The production of all classes of concentrates at Duenweg gave that district third place among southwest Missouri districts by a considerable margin. The output of blende concentrates at the Alba-Neck City camp was somewhat less than in 1910, but the production was large enough to give the district fourth place. The largest gain in zinc blende tonnage was made by the Thoms Station-Sherwood district, which advanced from thirteenth place in 1910 to fifth in 1911.

The production of both lead and zinc concentrates increased at Oronogo, but not sufficiently to prevent it losing fifth place, which it held in 1911. In Granby district the shipments of blende declined 676 tons, but there was a slight increase in the calamine output and an increase of 230 tons of galena, so that the value of the concentrates sold was very little less than in 1910.

The output of all classes of concentrates showed a further decline at Aurora when the figures are compared with the productions of 1910 and 1909.

The Carl Junction district increased its output of both galena and blende concentrates, and the development in 1911 assures a much larger production in 1912.

The Cave Springs, Wentworth, and Springfield districts also showed a largely increased output in comparison with that of 1910.

Ash Grove-Everton, Carthage, Sarcoxie-Reeds, Spring City-Beef Branch, Spurgeon, and Zincite districts all showed a decline in 1911 in comparison with 1910.

REVIEW BY DISTRICTS.

*Alba-Neck City district.*—The shipments of sphalerite concencentrates from this district in 1911 declined about 5,000 tons. The output, however, remained large and several new mines were developed which will add to the 1912 yield. The production of lead concentrates (328 tons) was very small compared with that of zinc, and some of the largest shippers of zinc blende concentrates reported no lead shipments whatever. The zinc blende production of the Quick Seven Mining Co. was again the largest in the district. Six shafts (including one sunk in 1911), ranging from 150 to 170 feet deep, were in operation. There are on the land four concentrating plants having an aggregate milling capacity of 600 tons per 10-hour shift. The Cliffwood Mining Co., on the Durston Mining Co.'s land, produced a very large tonnage of 62 per cent blende concentrates. Two shafts were utilized to hoist ore from levels as deep as 185 feet. The old 125-ton mill was operated, and in addition a new electrically driven concentrator of 200 tons capacity (10-hour shift) was constructed and operated most of the year. The Little Mary mine was worked for 8 months in 1911 and, notwithstanding the flooding of the mine, a large production of zinc blende concentrates was made. A new shaft was sunk and 15 prospect holes were drilled, good ore being reported in some of the holes. The concentrating plant has a capacity of 250 tons per 10-hour shift. Most of the galena concentrates produced in the district, as well as a large output of blende concentrates, came from the Reliance Mining Co.'s land. The shafts on the land range in depth from 40 to 200 feet, and two mills, each of 200 tons daily capacity, were operated. Among the lessees working were the Annalinda Mining Co., Lang & Stark, Green Mining Co., and Big Frog Mining Co. Lessees on the Penn Zinc Co.'s land made a good output, mainly from ore mined on the 190-foot level. The old Dana mine, on the Bowen lease of the Federated Mining & Milling Co., was operated by the Shamrock Mining Co. The shaft at this mine is 175 feet deep and the mill has a capacity of 150 tons per 10-hour shift. Other producers in 1911 were Pearson & Co. on the Calumet Zinc Co.'s land, the Ida May Mining Co. on the Patton land, the Cathers Mining Co. on the Fox land, the S. H. Veatch tailing

mill at the Battle Axe mine, the Little Maid Mining Co. on the McCaslyn land, and the Allington tailing mill on the lease of the Luke & Brown No. 3 Mining Co. The Big Kate mine of the Stag Mining Co. was under development. The Virginia Mining Co. thoroughly tested the Weaver land by drilling, sunk a 100-foot shaft, and began the erection of a large milling plant which will be in operation early in 1912.

*Ash Grove-Everton district.*—The mining in this vicinity is all shallow, none of the workings exceeding 50 feet in depth. The ore is raised by means of horse hoisters and cleaned on hand jigs. Most of the lead was mined on the Hayden lease of the Duncan land in Boone Township. The zinc carbonate and silicate produced was mainly the output of the Sturgis Mining Co., leasing the Shafer land.

*Aurora district.*—The production of this district in 1911 was considerably less than in 1910. Most of the mines were operated intermittently, little new work was undertaken at the old properties, though some drilling was done to the north of the proved area. A large proportion of the output was made by small lessees working shallow ground, the crude ore or "dirt" being treated at custom mills or sold in the rough.

The Coleman Bros. Mining Co.'s land was the largest producer of zinc blende concentrates, although it was operated only a portion of the year and was finally closed down and the corporation dissolved.

The Coleman & Scott Mining Co. operated one shaft and the 150-ton mill until July, 1911, when it closed down. The Early Dawn Mining Co. was engaged in developing the Stewart land and 40 acres of the Sedalia Mining Co.'s land. The old Methodist mill on the Stewart land was put in order and some ore milled in 1911. Large producers of both sphalerite and calamine concentrates were C. C. Plank, Decatur Lead & Zinc Co., Sphalerite Mining Co., and Black Land & Mining Co. Other producers of lead or zinc concentrates were the Boston Aurora Zinc Co., Cleveland Aurora Mineral Land, Federal Zinc & Lead Co., Stehm & Co. (Buddicke land), lessees on the Jones land, Kentucky Mining Co., North Pole Mining Co., Midland Mining Co., W. E. Stair, and lessees of the United Zinc Companies.

*Carl Junction district.*—This district was one of the most active in the Joplin region during 1911. The production of blende was over 1,400 tons more than in 1910, but this increase was only supplemental to the large amount of development work accomplished. Many drilling outfits were engaged in proving up ore bodies and the area of proved ground was largely increased. Many of the older companies also engaged in drilling their fees or leaseholds. Several new mills were completed or under construction during the latter part of the year and will contribute to a much increased output in 1912. The Moler-Smith Lead & Zinc Co. was the largest producer of zinc blende concentrates in 1911. The method of mining is by open cut, and a steam shovel was utilized a portion of the year to mine "dirt" from the 75-foot cut. Sufficient "dirt" can be hoisted during one shift to keep the two mills running double shift. The "dirt" milled only averages from 1.7 to 2 per cent in concentrates, but the ground is soft and the expense of delivering the ore to the mill hoppers is very low. The mill on the Dynes lease of the Avondale Land & Mining Co. was moved to the Smith land, and

many improvements were made on that property which should result in a much larger production in 1912. Subleases on the Hall and the Dynes leases of the Avondale land that produced concentrates in 1911 were the United Lehigh, Gilmore, and Gager. The Allen mine on this lease was taken over by the Gager Mining & Milling Co., and a mill with a capacity of 100 tons (10-hour shift) was constructed. The United Lehigh Mining Co. moved the 300-ton mill from the Highland mine, at Duenweg, to the Hall land and did about 1,000 feet of drilling. Gilmore & Co. worked very rich soft ground on the United Zinc Co. lease.

A new 150-ton (10-hour shift) concentrating plant was erected at the Homestead mine on the Excelsior Zinc & Lead Co.'s land. Ore was hoisted from the 120-foot level by means of 2 shafts and a good production of blende was shipped.

Although the 200-ton concentrating plant of the Weaver Mining Co. on the Anderson land, north of Carl Junction, was only in operation the last four months of 1911, the output of blende concentrates was large. The "dirt" hoisted was very rich and the concentrates are reported as having a zinc content of 62 per cent.

The McPherron mine, on the Otto lease of the Anderson land, made a good production of high-grade concentrates on hand jigs, and late in the year the mine was sold to the Weaver Mining Co. Some production of blende was made by lessees operating hand jigs on the Knight lease of the United Zinc Companies.

C. W. Landrum was sinking a shaft on the Hook land one-half mile south of the Moler-Smith mine. The Nilson land was also prospected and a shaft sunk 176 feet by the Galena-Joplin Lead & Zinc Co.

*Carthage district.*—The production of concentrates was over 50 per cent less than in 1910, but prospecting was active toward the end of the year. The Vesuvius Mining Co.'s lease on the Davey land was worked by N. C. De Vault and was the largest producer in the district.

The mine was abandoned in May, 1911, on account of caving, and new leases were obtained by the Vesuvius Mining Co. on the Wakefield and Hodson lands, where a shaft was sunk. The tailing mill of the Wise Guy Mining Co. commenced milling tailings from the Vesuvius mine in December, 1911.

The Mignonette mine was worked by the Leonard H. Mining Co. until May, 1911, when the lease was forfeited. The mine and 300-ton concentrator were then leased by J. L. Edwards, and the mine remained idle while the mill was used to work old tailings. No ore was hoisted at the Hayseed mine, but a good output of blende concentrates was obtained by reworking the tailing pile until the mill was destroyed by fire.

Other producing properties were the S. V. & D. Mining Co. on the Weaver land and scrappers on the Amsden land.

The Sampson land was opened up by the H. W. Cornell Mining Co. and a mill built which will be producing early in 1912.

*Cave Springs district.*—The production of galena concentrates increased from 56 tons in 1910 to 317 tons in 1911, and the production of blende concentrates increased from 1,761 tons in 1910 to 4,497 tons in 1911. The principal producer in the district was the H. L. Kramer mine, on the Miami Realty & Mining Co.'s land. Two shafts of 235

and 270 feet were operated. The 270-foot shaft, 6 by 14 feet in size, is equipped with a double-cage system, and the concentrating plant has a capacity of 500 tons per 10-hour shift. The other large producing mines were the Big Brownie and the Cave Spring mines, on the Schmidt land. The Big Brownie took over the Missouri Lead & Zinc Mills mine and sunk holes in the drifts, finding 12 feet of rich ore, which was hoisted through two shafts and concentrated at a 150-ton mill. Sublessees on the Murdock-McCulloch lease of the Hartley land, adjoining the Kramer mine, produced some ore from a depth of about 100 feet which was treated at custom mills.

The J. P. Mining Co. concentrator of 150 tons capacity was put in operation in November, 1911. The mine, which is opened up by two shafts, is on the Schmuck land, and the depth of mining was from 120 to 150 feet.

*Duenweg-Porto Rico district.*—The production of this district held up well when the handicap imposed on the "sheet-ground" mines by low ore prices is considered. There was a considerable decline in the lead output, and the production of sphalerite was about 2,000 tons less than in 1910. The shipments of zinc carbonate and silicate increased nearly 500 tons. The largest producers of sphalerite concentrates in the district were the Vogey mine and the Coahuila mine. The Central States mine produced 80 per cent of the zinc silicate ore. The December tract of the American Lead, Zinc & Smelting Co. (on which the Vogey mill, having a capacity of 1,000 tons per day, is situated) was operated by the owners and by Patton & Co. The July tract of the same company, which is equipped with a 200-ton mill, was worked by the Durston Mining Co. Sheet ground was mined on both tracts, the ore coming from the 180-foot level.

The Coahuila mine, on the Horton land, worked a 40-foot face of ore in sheet ground. The shaft is 240 feet deep, and the concentrating plant has a capacity of 300 tons per 10-hour shift. As a general rule the bottom of the "sheet" ground is fairly level, but this company on prospecting found that the bottom of the ore body dipped on each side of the shaft. Rich ore has been found to a depth of 10 feet in these dips and the bottom has not been reached, while the level of the roof remains the same. The 500-ton Trinity mill was not operated in 1911, but a good production of concentrates was made by the Carmean & Squires Mining Co. and the O. F. & L. Mining Co.'s mills, which are each of 250 tons capacity. The last-named plant was in operation for only eight months. Three shafts were used to hoist the ore from the sheet ground. On the Chew land the Mercantile Metal Milling Co. operated a 150-ton plant and made the largest production of galena concentrates in the district. The production of sphalerite was also large. The company's lease on the land expired during the year, and J. J. Anderson now has first lease.

The Wilson Mines Co.'s new 150-ton mill (10-hour shift), on the Boston-Duenweg Mining Co.'s land, was completed and in operation during the latter part of 1911. Another new producer late in 1911 was the Hill Mining Co., which sunk a 160-foot shaft and erected a new 200-ton (10-hour shift) mill.

The Grand Haven Mining Co. obtained a lease on the Ping land, sunk two shafts, and erected a 125-ton (10-hour shift) mill, which

was ready for operation in October, 1911. Ore from "soft" ground was hoisted from the 168 and 182 foot levels.

Three plants were operated on the Knol land in 1911 and a good output of lead and zinc concentrates was made.

The producers on the First National lease of the Knol land were the Durby Lead & Zinc Co., Nowata Mining Co., Lucky Four Mining Co., and Etta B. Mining Co.

The Melrose mine, on the Baker Realty Co.'s land, made a large output of sphalerite from ore in sheet-ground formation, which was milled at a 200-ton plant. The R. L. McGee Mining Co. worked the Bonnie Pattie lease of the Royalty Land & Mining Co. Other small producers of sphalerite, calamine, or galena concentrates were the Church-Mitchell Mining Co. on the Acme land, Connelly & McDonald, the Log Cabin Mining Co., lessees of the Crown Crest Zinc & Lead Co., Federated Mining & Milling Co., Jasper County Royalty Co., Stevison Jones & Co., Unex Lead & Zinc Co., and Henry Weymann.

Most of the calamine ore production from the Sadtler Lead & Zinc Co.'s land was produced by the Emma C. Mining Co. from the 110-foot level.

The sublease of R. L. McGee from the Home Talent Mining Co. on the Hall land was transferred to the Central States Mining Co. This lease was one of the largest producers of calamine ore in Missouri in 1911. Two shafts were in operation and a new 200-ton (10-hour shift) mill was built during the year.

*Granby district.*—Most of the producing territory belongs to the Granby Mining & Smelting Co., and the total production was large, the relative quantities of zinc silicate, zinc blende, galena, and lead carbonate being in the order named. The total production of concentrates in 1911 showed little variation from that of 1910. The output of sphalerite was considerably less than in 1910, but the production of galena increased about 250 tons and that of zinc silicate increased 95 tons. Much of the mining by small companies and by individuals is in shallow workings that yield galena and zinc silicate ore. The larger producing lessees on the Granby lands were the Broken Hill Co., Cole Co., Golden Rule Mining Co., Jack Snipe Mining Co., Little Boss Mining Co., Mascot Mining Co., Katy Mining & Milling Co., J. R. Underwood Mining Co., Billiken Mining Co., and Granby Sludge Co. The depth of mining varied from very shallow openings to 250 feet, and 11 concentrating plants were operated in 1911.

The 200-ton concentrating plant of the Granby Mining & Smelting Co., which was the largest in the district, was destroyed by fire in 1911. A new mill of larger capacity was erected, which is so equipped that it can be used to concentrate either blende or calamine ore. Many of the lessees on this land have no concentrating equipment and a large tonnage of ore is treated at custom mills or sold in the rough. Prospecting was very active during the latter part of the year 1911, the high price paid for calamine ores inducing active exploration by many operators having only limited resources.

The Mascot Mining Co. operated partly on Granby land and partly on Davis land. Other producers on the Davis land were the Little Four Mining Co. and the Stanley Mining Co.

Martin & Co. hoisted some zinc silicate through a 60-foot shaft on the St. Paul land which was milled at the Granby mill.

At Fairview, southeast of Granby, in Newton County, the Pioneer Mines Co. developed a mine sufficiently to warrant the construction of a concentrating plant, which was commenced in December, 1911, and completed early in 1912.

*Joplin district.*—This district made the second largest production in southwest Missouri. The 1911 sales of concentrates were as follows: Galena, 6,158 tons; lead carbonate, 45 tons; zinc blende, 41,300 tons; carbonate and silicate of zinc, 1,707 tons. The total value of all concentrates sold was $2,013,976. As compared with 1910 the sales of galena and lead carbonate increased 45 tons, zinc blende decreased 5,900 tons, and zinc carbonate and silicate increased 304 tons, and the total value was $229,297 less.

The number of producers reporting, though fewer in number than in 1910, was larger than in any other district, and the area included in the camp is more extensive. About 85 per cent of the zinc blende concentrates were recovered from ore mined in "soft" ground. Though new mining operations were overshadowed by the more feverish activity in the outlying camps of Thoms Station, Carl Junction, and Lawton, there was a large amount of drilling done and many prospects were opened. New operations involving large amounts of money were few in number, but improvements of moderate cost were as numerous as in the preceding year.

The production of both lead and zinc concentrates by lessees on the Joplin tract of the Granby Mining & Smelting Co. was much larger than that from any other land, although individual mines in the district produced more than any single lease on the Granby property. The average depth of mining by Granby lessees was 160 feet, and 14 concentrating plants, with an average capacity of 150 tons each per 10-hour shift, were operated. The producing mines on the Granby lands were the Amalgamated, Bay State, Conqueror, Underoof, Theurer, Omega, Katy Lou, Lounetta, and Grace; also the Gravity, Connecticut, and Pearl tailing mills.

The next largest production of zinc blende came from the land of the St. Louis-Joplin Lead & Zinc Co. The ore was mined from levels between 100 and 200 feet, and four concentrating plants were operated in 1911. The land was prospected by drilling and new ore bodies were located. The mill of the Wilcox Mines Co. at the John Jackson mine was converted from steam to electric drive, and a new mill was erected at the Good Enough mine. The principal producing leases on the St. Louis-Joplin land were the Joplin-Kentucky, Jack Pot, A. B. C., Putnam, and Wilcox (John Jackson).

A large production of both lead concentrates and zinc blende concentrates was made by Mattes Bros. and by lessees of the Anderson Mining Co., American Zinc, Lead & Smelting Co. (Midway tract), Continental Zinc Co., Dirigo Land & Leasing Co., Lambert land, Rex Mining & Smelting Co., C. C. Playter (Gordon Hollow land), and Scotia Mines Co. The producing leases on the Mattes land were the Duquesne, Jackson, and Mattes & Hart; on the Midway tract the Rheno and the John Bull (now called the New Dividend); on the Anderson the Red Lion, Lee Hall, and Helm. The mill at the Red Lion was burned late in the year. Seven concentrating plants were operated on the Continental tract including those of the

Kohinoor, Harvard, and Brown mines. The productive subleases on the Dirigo were the Paragon, with a 150-ton mill, and the West Seventh Street, with a 90-ton mill. On the Lambert land the Symmes mine was worked by the Morsman Sly Mining Co. (now Morsman Mining Co.), and the Osceola lease was operated by the Waneta Mining Co. Several new leases did development work. Most of the ore hoisted by lessees on the Rex land came from levels between 80 and 100 feet and was concentrated at three mills, two of which are of 75-ton capacity per shift and the other 50 tons per shift. The only producing mine on the Scotia land was the Tilho. A large quantity of ore was hoisted through 2 shafts and milled at a 150-ton (10-hour shift) plant. The northeast 40 acres of the Gordon Hollow tract of C. C. Playter was sold to the General Lead & Zinc Co., and the northwest 40 acres was sold to the Marion Land Co. The large producers on the Gordon Hollow tract were the Niagara Falls and the Puritan, both of which mines are equipped with concentrating plants of 150 tons (10-hour shifts). The Friel & Phillips custom mill is also located on the Playter land.

Large shipments of blende concentrates were made by the following: Sampson Mining Co., Falls City Mining Co., Atchison Mining & Milling Co., Berry & Pickson (Leckie land), Bullfrog Mining Co., Chicago-Joplin Mining Co., Prairie Chicken Mining Co., lessees on W. E. Johnson land, Hecma Mining Co., Ohio Land Co., lessees on the Leonard Realty Co.'s land, Hemphill Mining Co., Paoma Mining Co., Rabbit Foot Zinc Mining Co., Ten Per Cent Prospecting Co., United Zinc Co. (Chitwood 80), and the Eyster lease on the Banner Investment Co.'s land. The Falls City Mining Co.'s large 500-ton plant on the Pate lease of the Liberty Mining Co. was put in operation the latter part of 1911 and turned out a good production of concentrates. The Hackett mine and 600-ton concentrating plant were only operated for brief periods and the property was transferred to the Ristoria Lead & Zinc Co. The largest producers of zinc carbonate and silicate ores were sublessees of the No Name Mining Co. on the L. B. Jones land. Other producers were lessees on S. B. Jones's land, Wyhoff & Tinker on the Butts land, lessees of the Shoal Creek Mining Co., the Roaring Springs Land & Mining Co., and the Saginaw Investment Co.

The small custom concentrating plant of Lee Williamson was burned down after being in operation most of the year. Other shipments were made in 1911 by the Blue Grass Mining Co., Marion B. Mining Co., Muskingum Lead & Zinc Co., Billy Sunday Mining Co., Joplin Consolidated Mining Co., and by sublessees of John G. Dinkelbihler, Henry Weymann, Grundy Realty Co., Home Land & Loan Co., Missouri Lead & Zinc Co., Charles Montgomery, Owensboro-Joplin Mining Co., Rob Roy Zinc Co., J. B. Robb, Scranton Mining & Smelting Co., South Joplin Lead & Zinc Mining Co., St. Paul Mining Co., P. L. Swartz, Old Dominion Mining Co. (Taylor land), and F. L. Yale.

*Oronogo district.*—In 1911 the production in the Oronogo district of lead concentrates increased 164 tons and of zinc blende concentrates 1,791 tons when compared with the output in 1910. Most of the producing territory in the district is owned by the Granby Mining & Smelting Co. Little of the "dirt" came from workings above the 70-foot level and nearly all of the production was made by three or four companies. The most prominent producer on Granby land

was the old Oronogo Circle mine which had a larger output of galena and blende concentrates than any other mine in Missouri with the possible exception of the Davey mine of the American Zinc, Lead & Smelting Co. at Webb City. Four shafts of 160, 240, 230, and 230 feet, respectively, were operated in 1911, and the ore was concentrated on the large 400-ton mill. Various improvements for the more rapid and economical handling of the ore was made. Steady development work has opened up large bodies of ore sufficient to supply the mill for a long period. Core drilling by the company at the 230-foot level indicates a large body of ore at depths ranging from 250 feet to 380 feet.

The Pinnacle Mining Co. had on the Granby land two 230-foot shafts in operation and produced a large output of both lead and blende concentrates. The "dirt" averaged 1 ton of galena to 2 tons of blende concentrates. The concentrating plant has a capacity of 250 tons (10-hour shift). The only other large producer on Granby land in 1911 was the Oronogo Mining & Development Co., which erected a new concentrator in 1911. The Iris B. Mining Co. worked the Old Judge mine during a portion of the year. The old Needmore tract in the northern part of the Granby land which formerly was a large producer from shallow workings was taken over by J. L. Newlands & Co. There are two shafts on the ground, one in ore at 144 feet where drifts have been run, and another, the pump shaft, 190 feet deep. A mill with a capacity of 300 tons (10-hour shift) was under construction at the close of the year.

*Sarcoxie-Reeds district.*—The production of this district, which was almost entirely of zinc blende and zinc silicate, showed a large decrease when compared with the output of 1910. Development in 1911 was more active than in 1910, and the 1912 output will likely be larger.

The Cameron mine yielded the bulk of the blende concentrates shipped in 1911. There is a 250-ton mill on the property which is opened up by a 242-foot shaft. The development work largely consisted in opening up ore bodies between the 190-foot and the 242-foot levels.

The Lone Pilgrim and Optimo mines, on the H. B. Boyd land, produced blende concentrates and the Copperhead mine yielded most of the zinc silicate mined in the camp. A new mill was built by the Lone Pilgrim Mining Co.

The old Plymouth Rock mine, on the Goucher land, was idle most of the year and the output was small. The Overland Mining Co. developed a new deposit of zinc silicate a few miles south of Sarcoxie, but no sales were made in 1911.

The Red Fox Mining Co. produced a small quantity of zinc silicate by means of hand jigs from the Chappel land. The lease was acquired by the Reeds Lead & Zinc Mining Co. Sublessees of the Stealey Development Co. on the Webb land, 4 miles west of Sarcoxie, shipped zinc silicate, galena, and lead-carbonate concentrates, taken out in sinking a 50-foot shaft. A new strike was made in virgin ground on the E. H. Newby lease of the Clark & Willoughby land, 5 miles west of Sarcoxie, by the Lucky Ben Mining Co. One shaft was in operation, and the ore was encountered at the 130-foot level. Drifts were run and a 20-foot face of rich ore is reported to have been opened up.

*Thoms Station-Sherwood district.*—In 1911 this district produced 288 tons of lead concentrates and 10,356 tons of blende concentrates more than in 1910 and advanced from thirteenth to fifth place amongst southwest Missouri districts. The output of lead concentrates in 1911 was 641 tons, valued at $35,382, and the output of zinc-blende concentrates was 12,603 tons, valued at $443,822. The percentage of concentrates in the "dirt" milled was higher than in the other Missouri districts. The increased yield came from comparatively few of the many mines that were opened during the year. The active development which commenced late in 1910 continued throughout 1911. No similar area in Missouri was as actively explored with drills. Many new concentrating plants were built and operated and others were under construction. The ore being located at comparatively deep levels in very soft ground made shaft sinking and the opening of the mines a work requiring extra care and time. Many new mills will be erected in 1912 and the district should show a much-increased yield. The tract having the largest production was that of the Mexico-Joplin Land Co., but the Sitting Bull was the largest single producing mine. This mine, which is on the Brinkerhoff land, was originally opened by J. M. Short in 1910. A shaft was sunk 189 feet in very soft ground and a 200-ton concentrating plant was built. The recovery of concentrates from the dirt milled was very high, averaging over 14 per cent, of which very little was galena. The mine was one of the sensational discoveries of the year and was responsible for much of the development in the district. The Mary E. mine, also opened by J. M. Short, made some output of concentrates from ore taken from a 160-foot shaft.

The Mexico-Joplin Land Co. owns 560 acres of land, upon which many new lessees were working. The depth of mining varied from 150 to 200 feet, and three new plants were built and others were in course of erection. The largest producer on the tract was the Mary C. Mining Co., which is equipped with a 150-ton mill and made an output only slightly less than that of the Sitting Bull. The Katy Mining Co. was another one of the large producers in 1911. Other producers on the Mexico-Joplin land were the High Tariff, with a 162-foot shaft and a 150-ton mill, the Federated, Maggie G., Freeman, Lillie, Hustler, Hoosier, and Katherine.

The mines on the Excelsior Lead & Zinc Co.'s land reporting production in 1911 were the Four Corners mine of Babson, Batten & Cox and the Wiser lease. Two shafts were used to hoist ore, and there were two concentrating plants in operation.

The Chapman & Lennan lease, on the Hancock-Connor land, was a good producer of some of the highest-grade lead and zinc concentrates in the district. The Modoc Mining Co. built a new 250-ton (10-hour shifts) mill on the Chapman, Lennan & Carter land, which made a fair production of concentrates. The Oak Hill mine, on the Missouri Hill Zinc Co.'s land, produced some high-grade concentrates by means of hand jigs. The C. W. Landrum lease, on the Park Land & Mining Co.'s property, was prospected and a mill erected. The Murphy land was drilled by J. M. Short, and a shaft was sunk 189 feet at the Bucyrus mine, from which a small production incidental to development was made. The name of this mine was changed to Pocahontas, and a new mill was built. Five or six sublessees were developing the S. B. Wyatt (now Lagonda Mining Co.) lease on the

Dixon land, of which two, the Great Wonder and the Shepherd Dog, produced some concentrates in 1911. The only productive mine on the Snapp land was the Cherokee sublease of the Ten Per Cent Prospecting Co. The shaft on the mine was sunk 145 feet and the ore taken out was concentrated on hand jigs. A number of other lessees were working on the tract, of which the most prominent were the Vinegar Hill Zinc Co., Little Pumpkin Mining Co., and Coats & Ortt. The Little Israelite Mining Co. and the Big Irishman Mining Co., located on the Rusk land, were also among the new producers in 1911. The ore was mined from a depth of 140 to 160 feet and concentrated in a 200-ton mill built in 1911. The Tyson, Dynes & Yankie land was well prospected, a 135-foot shaft was sunk and a 125-ton mill erected late in the year. Shafts were sunk on the Taylor land by the Heather Mining Co. and on the Kost land by the Rich-in-Ore Mining Co. The last company erected a 150-ton concentrating plant, which was in active operation early in 1912.

*Spring City-Beef Branch district.*—The production of all classes of lead and zinc concentrates declined in this district, and the total value of the concentrates sold was $61,722 less than in 1910. Mining conditions were not promising until late in 1911 when a revival took place which will probably result in an increased production in 1912. The largest quantity of lead and blende concentrates was reported by lessees on the Adam Scott lease of the McCown land. The producing mines of this land were the Delta, Vista, Halloween, Platta, and Slick Rock. The ore was hoisted from levels of 100 to 180 feet, and there were four concentrating plants in operation part of the year. The mill at the Delta and that at the Slick Rock mine of the Spring City Lead & Zinc Co. were rebuilt during 1911 and hand jigs were installed at the Platta. The Delta mine, from which Creech & Co. made a large output of concentrates, was sold to Watson & Co. At the Slick Rock mine, in addition to rebuilding the mill, a new shaft was sunk northwest of the mill, opening up a good body of ore. The Sunrise and Fairview mines, on the J. W. Allen land, made the largest tonnage of carbonate and zinc silicate concentrates, in addition to a good production of galena and zinc blende. The shaft at the Sunrise was down 148 feet and a 100-ton mill was operated. This lease was purchased during 1911 by the Minor Heir Producing Co., a new shaft started, the underground workings were extended, and many improvements were made in surface equipment. The Mary E. mine, on the Haines land, produced zinc silicate concentrates up to May, 1911, when the mill was sold and removed from the land. A good production of zinc silicate was made by T. F. McKinney on the Hoge land. Four shafts, ranging from 30 to 90 feet deep, were worked, and the dirt was concentrated on hand jigs. All the output of the Craycroft lease of the Leake land was cleaned on hand jigs.

Several lessees on the St. Paul Mining Co.'s land shipped galena, blende, and zinc silicate concentrates and some prospect drilling was done. The ore bodies are at depths ranging from 65 to 110 feet, and 7 shafts were worked in 1911. Galena and blende concentrates were produced by the Glenn Mining Co. on the White Oak Mining Co.'s land. There were 2 shafts in operation, and the mill has a capacity of 100 tons (10-hour shift).

Other producers of zinc silicate and lead carbonate were L. Gingrich on the Bales land and lessees on the lands of the Zeta Land & Mining Co., Henry Weymann, and J. M. Lambert. A large amount of development work was done on the Bittick land, which opened a good run of lead and zinc.

*Springfield, Wetherill, and McDowell districts.*—The production given in the Missouri table for 1911 for the Springfield district represents the output of the Bray Mining & Milling Co., located on Pierson Creek, 5 miles southeast of Springfield. This company reopened the Daisy mine in the latter part of 1910 and operated it steadily during the year 1911. A new 110-foot shaft was sunk on the same opening which has produced ore since 1906, and the old 78-foot shaft was also worked. The ore deposits are in channels mixed with gumbo and in sheets in the roof, which is blue shale. The "dirt" or ore was dressed in a 100-ton concentrating plant and yielded about 8 per cent of concentrates. The average metal content of the galena concentrates recovered was over 80 per cent, and the average zinc content of the blende concentrates was between 63 and 63.5 per cent, with very little iron. The old Badger mine, which has a shaft 258 feet deep and a 50-ton mill, was acquired by the Choteau Mining & Land Co. The mine was unwatered, the shaft retimbered, and the mill rebuilt and enlarged to a capacity of 75 tons (9-hour shift). Some ore was hoisted but was not concentrated until 1912.

The only mine in Howell County operated in 1911 was the Alice mine of the Empire Zinc Co., near Wetherill post office. It had a large output, but made no shipments in 1911. The ore, which is carbonate of zinc, carrying limonite, crops out at the surface and is worked down to a depth of 60 feet in a large open pit; there is ore still showing in the bottom of this open cut. The zinc carbonate is cleaned in a log washer having a capacity of about 200 tons daily. There was no production from the McDowell district, in Barry County, and the only work of any magnitude was by the Walt-England Mining Co. on the Gray & McNally land located 1 mile south of Butterfield, on the Frisco Railroad. Six drill holes were sunk on a 40-acre tract, and ore was struck in every hole at a depth of 95 to 100 feet. Shaft-sinking machinery was installed, and a mill will be erected. Small shipments of zinc silicate were made by Solomon Bros. from shallow workings on the Pearce land near Larrusel. The Jersey Fissure mine, at McDowell, was closed down the entire year.

*Spurgeon-Seneca district.*—The total value in 1911 of the lead concentrates produced in this district was $52,389, an increase of $13,235, and the total value of the zinc concentrates was $10,839, a decrease of $10,647 when compared with 1910 figures. Approximately twice as much lead concentrates was sold as zinc concentrates, and only four southwest Missouri districts produced more lead than the Spurgeon-Seneca district in 1911.

The small output of zinc blende came from the Moseley mine and from lessees on Granby land, and the latter land yielded 75 per cent of the zinc carbonate and silicate. The Moseley mine was reopened late in the year by the Moseley Valley Mining Co. and a new 200-ton mill built which will be in operation in 1912.

The Estawawa, Goodwin, and Henderson leases on the Granby land were not as large producers as they have been in former years.

The largest producer of galena and lead carbonate was the First Chance Mining Co. on the Davenport land. The ore was hoisted by means of three shafts from levels ranging from 40 to 64 feet in depth and was concentrated on a mill having a capacity of 50 tons (10-hour shift). No zinc concentrates have been shipped from this mine. Carter & Co. also shipped lead concentrates from ore mined on Davenport land. The Silver Dime Mining Co., on the O'Neill land, was the second largest shipper of lead concentrates. A 100-foot shaft was in operation, and the ore was concentrated by means of hand jigs.

Some prospecting was done on the Bucklen land and the Silver Dollar Mining Co. milled some lead ore taken out at the 92-foot level. Woolridge & Co. and James & Co. reported some shipments of zinc silicate taken from very shallow workings on the H. H. Gregg land. The Lost Creek Mining Co. worked on the Gallemore land near Seneca and shipped a fair production of galena concentrates.

The Lion Mining & Milling Co. opened a new mine east of Seneca on the Wasserman lease of the Newton Country Fruit Farm Co.'s land. A 95-foot shaft was sunk and a new 150-ton mill built late in the year. Prospect and development was done by the Racine Mining Co. on the Buzzard land and by the Mokoma Mining Co. and the Wildcat Mining Co. on the Becker land.

*Stotts City district.*—There was no new work of any importance done in this district, and the production in 1911 was about the same as that of 1910. The largest producing property was the Gundling mine, leased to the American Zinc, Lead & Smelting Co. The ore body is opened by three shafts, one of which is 300 feet deep and each of the others 230 feet deep. The only other producing property was that of the Keystone Mining Co.'s lease on the Stott land.

*Wentworth district.*—The value of the production of zinc concentrates in this district increased from $5,714 in 1910 to $19,885 in 1911, and there will probably be a much larger increase in 1912. The largest shipper in the district was the Wentworth Land & Mining Co. on the Bowen lease. This company operated the Alice Dayton mill, which was finished early in the year. No concentrates were sold from the Mocking Bird mine on the Poland land, and development work only was done on the Smith land by the Pierce City Mining Co.

*Webb City-Carterville-Prosperity district.*—This district includes most of the original and typical "sheet" ground territory, and the low prices paid for zinc-blende concentrates during the greater part of 1911 caused a continued decline in the output when compared with that for 1909 and for 1910. Only a very small percentage of the district production is derived from "soft" ground, and the prominence of the "sheet" ground mining is indicated by the fact that about 80 per cent of the total production of crude "sheet" ground ore came from this district. The recovery of galena concentrates in southwest Missouri from ore mined in "sheet" ground was about 25,000 tons, of which this district produced over 22,500 tons. The quantity of zinc-blende concentrates in southwest Missouri derived from ore mined in "sheet" ground was over 106,000 tons, or nearly one-half of the total zinc-blende output of the entire State, and of this large quantity the "sheet" ground mined in the Webb City-Carterville-Prosperity district yielded about 87,000 tons. The recovery of galena and zinc-blende concentrates from crude ore aver-

aged only 2.6 per cent in both 1910 and 1911. Some of the mines were shut down for a portion of the year, and others operated only single shift, but on the whole operations showed no great reduction, and the district was in a position, by increasing the output, to take advantage of the high prices prevailing late in the year.

The production of lead concentrates in 1911 was 24,626 tons, or 1,854 tons more than in 1910, and the value increased $189,491, mainly on account of the higher price paid for galena concentrates. The average lead prices paid in this district were somewhat larger than in other Missouri camps—probably the result of competition by the new lead smelter at Webb City, which was blown in early in January, 1911. The production of zinc-blende concentrates in 1911 was 93,462 tons, a reduction of 11,326 tons when compared with that of 1910. The total value of the concentrates sold was $5,114,784 in 1911 and $5,465,563 in 1910.

The Davey tract of the American Zinc, Lead & Smelting Co. produced the largest combined output of lead and zinc concentrates in 1911. The lead concentrates amounted to one-fifth of that of the entire district output. The Davey mines, Nos. 1, 2, 3, and 4, are in the vicinity of Prosperity and are equipped with four double-compartment shafts and four concentrating plants, having a combined daily capacity of over 3,500 tons per day. Additional sludge tables and classifying equipment were added to the mills in 1911. A pump shaft was sunk and to it a drainage drift, 1,080 feet in length, was driven. The Hockaday tract belonging to the same owners was worked by the Vantage Extraction Co., and ore was hoisted from about the 130-foot level by means of two shafts. One 250-ton mill was used to concentrate the ore mined on the Hockaday tract, and the Berry Sludge Co. treated tailings on another 250-ton plant. The only operations on the Richland tract was by scrappers.

Lessees on the Guinn land reported the second largest output of concentrates. The capacity of the concentrating plants on the land was in excess of 4,000 tons per day. The leasing companies that produced in 1911 were as follows: Electrical Lead & Zinc Mining Co., Hurry Up Mining Co., Ice Plant Mining Co., Mercantile Metal Milling Co., Osceola Lead & Zinc Co., Realization Royalty & Investment Co., Rhea Lead & Zinc Co., Sanford & McCroskey, Mutual Lead & Zinc Co., and Ground Floor Mining Co. One of the largest producing companies on the Guinn land was the Mercantile, which operated mills Nos. 4 and 5, each of 300 tons capacity, and overhauled mill No. 1, which had been idle for over a year. The Electrical mine and 150-ton mill were leased to the Incline Mining Co. during the year. The Schoenheuer-Walton Mining Co., a sublessee of the Rhea lease, made one of the largest outputs on the tract.

In the territory between Webb City and Carterville the lessees of the Bradford Kansas City Mining Co. made the third largest output in the district in 1911. The sublessees were the Disbrow Mining Co., the Dinger Mining Co., and the Empress Mining Co. Five shafts were worked, and the ore was milled on three plants, each of 300 tons capacity.

The lessees of the Center Creek Mining Co. in this vicinity were also large producers. The principal producing leases on the Center Creek Mining Co.'s land were the Mercedes, McConey, Comet, Rogers-Miller, Ramage, and Pacific Sludge Co. The production of

S. Y. Ramage on the Morgan 40 was large, but all the zinc-blende concentrates were not sold during 1911. One shaft was used in hoisting, and the ore was concentrated on a 225-ton (10-hour shift) plant. A new 500-ton mill was in course of erection. The output of the Underwriters Land Co. from the Worthington land was one of the largest made in this district. The 1,000-ton Yellow Dog mill, half of which was situated on this land, was destroyed by fire in November. The old 250-ton mill (10-hour shift) was then run double shift. The Golden Glow mine, on the Underwriters Land Co.'s fee, also made a very large output.

Companies operating in the "sheet" ground north of Webb City and producing heavily were the Providence Mining & Milling Co. on the Ashcraft land; the White Dog Mining Co., Osceola No. 1 Lead & Zinc Co., and Mineral King Mining Co. on the Kelley land; the Oakwood Mining Co., Edmund Lyon, Wingfield, and Little Princess leases on the Bowman, Ware & Scott land; the Minor Heir Producing Co. and the Vintage Extracting Co. on the H. M. Baker land.

The Continental Zinc Co. produced large quantities of both lead and zinc concentrates from the Litteral tract at Prosperity. The Lucky Budge, Dominion, and Avondale leases on the Prosperity 40 of Ben C. Aylor were also very productive. At the Elizabeth mine (a sublease of the Avondale) a new haulage system was installed underground. The haulage is of the endless cable type operated by a 5-horsepower electric motor, and is said to be capable of handling 800 tons of dirt per shift. The large producing leases on the Newell Morse Royalty Co.'s land were the Athletic Mining Co. and the Winslow Mining Co. (now called the Bertha A. Mining Co.).

A new 500-ton (10-hour shift) electrically driven mill was built by the Providence Mining & Milling Co. on the Missouri Zinc Fields Co.'s land on the site formerly occupied by the Yale Zinc Co. The mill is constructed of galvanized iron and has 4 jigs and 3 sludge tables. The output of concentrates on the Byrd land came from the leases of the Good Mining Co. and the Old Dominion Mining Co. The Culpeper Mining Co. operated three shafts and a 400-ton mill (daily) on the Cunningham land. The power of the 150-ton mill of the Eleventh Hour Mining Co. on the E. J. Chinn land was changed from steam to electricity. Two shafts were operated and a good production of concentrates was made. The greater portion of the output from the Pike Land Co.'s property was made by the Nowata Mining Co. The Gibson Mining Co. also worked a lease on this land.

Other prominent shippers of concentrates in the district in 1911 were the St. Paul Mining Co., Boston Get There Zinc Co., Moark-Nemo Lead & Zinc Co., Bendelari Land Co., Talisman Mining Co., Double D. Mining Co.; the Doane Mining Co. and Endeavor Mining Co. on the Chinn land; Dixie (old John D.), C. T. & S. Mining Co. (old McKinley), and Sawyer mines on the Connor land; Federated Mining & Milling Co. on the General Lead & Zinc Co.'s land and on Connor land; and the lessees on T. T. Luscombe land; Prosperity Land & Mining Co. (Troup 40); Rochester Land & Leasing Co.; Royalty Land & Mining Co.; and Sunflower Lead & Zinc Co. The leases and mines specified comprise merely the better

known and most productive ones in 1911. Upon many others development work was done, or an output varying from small to fairly good was made.

*Zincite-Smithfield district.*—Although the production of this district in 1911 was slightly less than in 1910 there was a resumption of work in many of the old properties and the opening of a number of new leases during the last few months of 1911. This activity will result in a largely increased output in 1912.

The Parkinson, Graves & Harper land was leased by the Minor Graham Mining Co. in October, 1911, and the power of the 150-ton mill at the Clara Belle mine was changed from steam to electricity. The productive leases on the Belleville Land & Mining Co.'s property were the Dorothy Marie, Theurer & Kennedy, and Haley (formerly the Midnight). The Haley Mining Co. sunk a new shaft to the 140-foot level. Some mining was done on the De Graff lease of the R. F. Brooks land by Atgate & Co.

On the Wyssbrod land the producers were the Daylight and Huckleberry mines. The two 100-ton mills were operated intermittently and the ore treated came from between the 80-foot and 90-foot levels. The small output on the land of the Geneva Mining & Leasing Co. was made by scrappers.

The Renfrow land was leased to John W. Brooks, and development work only was done in 1911. The L. C. Moses Mining Co., a sublease of the Missouri Standard Mining Co., made a good production by means of hand jigs from a mine on the Leckie land.

The Holy Moses mine on the United Zinc Co.'s lease of the Leckie land also made some output by means of hand jigs and then erected a mill with a capacity of 100 tons (10-hour shift).

The old Lincoln mine, at Smithfield, was reopened by the Golden Rule Lead & Zinc Co. and made a good output of high-grade concentrates with hand jigs. In the latter part of 1911 the property was transferred to the Aberdeen Mining Co. and the erection of a 150-ton mill was commenced, which was in operation early in 1912.

## CENTRAL AND SOUTHEAST MISSOURI.

The ore deposits of central and southeast Missouri reach in a more or less connected belt from the region of Benton, Pettis, Morgan, Moniteau, Cole, and Miller counties on the northwest to the northern and eastern flanks of the St. Francis Mountains on the southeast. It is also true that there are scattered areas where more or less mining has been done all the way between the northwest end of this belt and the Joplin region, so that strictly speaking the lead and zinc deposits of Missouri practically form a zone around the northern half of the Ozark dome.

The deposits in the counties named above, corresponding to the central Missouri region, are of the general type of those in the Joplin region, in that the ores consist of galena and sphalerite, or the oxidized derivatives of those minerals, and occur in association with solution breccias and sink-hole shale patches, the ore being found in the Cambrian and Ordovician dolomites and included cherts and occasionally in the Pennsylvanian shale. The occurrence of ore in crevices or thin vertical sheets is very common, but practically all the production of ore has been from sink-hole breccias or "circles," a

form of deposit noted also as important in the southwest Missouri area.

The southeastern part of the belt, in the vicinity of the St. Francis Mountains, forms the disseminated lead region of southeast Missouri. The southeast Missouri deposits have been known and worked for about 200 years. The earlier workings were shallow, and even yet considerable shallow lead is raised, generally in connection with the mining of barytes, or "tiff," as it is locally known. The mines in the disseminated lead region range from 100 feet to about 550 feet in depth, depending on the depth from the surface to the basal portion of the Bonneterre limestone.

The ore deposits now worked are almost wholly in the lower part of the Bonneterre limestone, where they occur in disseminated form over large areas, relatively richer in the vicinity of the intersecting crevices and joints. The crevices show little if any displacement, and there are no breccias of consequence. The copper, nickel, and cobalt in Madison County occur with galena and marcasite in blanket formation in the carbonaceous beds of parting at the contact of the Bonneterre limestone with the Lamotte sandstone below, and in the vicinity of the intersection of this contact with the sloping surface of the pre-Cambrian rocks. Both the Bonneterre and the Lamotte formations are of Cambrian age.

Prospecting is done by means of the diamond drill, and extensive campaigns of drilling have been prosecuted in the vicinity of all the important producing tracts. Just before the business depression in 1907 there were about 100 diamond drills actively engaged in prospecting. In 1908 and 1909 very little drilling was done other than that necessary in mining. In 1910 and 1911 drilling became somewhat more active and several tracts were prospected.

The diamond drill is also used in mining as an aid in following the ore. Cores are taken from the heading in various directions, straight ahead, at angles upward, downward, or to the side, and from these cores the direction to drive the heading is determined.

The ore in the southeast Missouri region is almost wholly lead, although a considerable zinc deposit occurs at Valle mines, some 6 miles north of the Bonneterre district. A certain percentage of zinc is also found in the disseminated lead ore, the ore from one shaft being reported to run occasionally as high as 2 per cent of zinc for a week at a time. The zinc occurs more plentifully in the Leadwood-Flat River districts, and may lie near the contact of the Bonneterre limestone with the Lamotte sandstone or some distance above it. In the lead concentrates zinc ranges from 1 to 5 per cent or more. In the maximum proportions mentioned the zinc makes trouble in lead smelting, and for this reason some of the concentrating plants remove the zinc as a table middling. As the quantity of zinc is increasing, it will no doubt before long become a salable product of the district. In one mill now operating, middlings, containing 20 per cent of zinc, are being discarded at the rate of a ton daily. An interesting feature of the zinc middlings is that they carry a disproportionately large part of the silver content of the ore, the silver being apparently associated with the zinc rather than with the lead.

Copper, nickel, and cobalt also occur in the ore, in greater quantity in the vicinity of Fredericktown, and in small quantity, irregularly,

in nearly all the deep mines. It is only near Fredericktown that the copper, nickel, and cobalt content of the ore has been the object of mining, yet a concentrate of these metals has been recovered as a table middling at several plants in other parts of the district, and in some instances has been a source of income.

The lead ore of southeast Missouri carries a small proportion of silver, the average being a very little over 1 troy ounce to the ton of lead concentrates. The resulting pig lead likewise carries silver, together with a little copper, nickel, cobalt, and traces of antimony and arsenic, and is sometimes commercially known as "Missouri chemical" lead in contradistinction to "Missouri soft" lead from the Joplin region. An average of about 15 per cent of the total lead concentrates from southeast Missouri is desilverized. The silver so recovered does not pay for the refining charges, but the desilverized lead commands a slightly higher price, making up the difference. As the silver content of the concentrates is so small it is disregarded in their sale, and therefore the smelter reports are relied upon for the silver production. As explained already, the quantity of silver produced during any year bears no direct ratio to the quantity of silver-bearing lead concentrates smelted during that year, for the reason that the silver bullion is stored and refined in batches at convenient times.

The silver production of southeast Missouri was 49,867 fine ounces in 1911, as compared with 33,096 ounces in 1910, with 14,188 ounces in 1909, and with 49,131 ounces in 1908. The silver production of 1911 was recovered from 51,109 tons of lead concentrates, that of 1910 was recovered from 35,002 tons, that of 1909 from about 31,000 tons, and that of 1908 from 26,488 tons.

The tonnage of crude lead ore mined in 1911 was 3,974,712 tons, against 3,693,523 tons in 1910. The crude ore in 1911 yielded 5.5 per cent of lead concentrates which averaged 67.3 per cent of lead. The average value per ton of the lead concentrates in 1911 was $46.94, as compared with $44.35 per ton in 1910, and the concentrates were higher in lead content than in 1910. The output of galena concentrates increased from 210,890 tons, valued at $9,360,309, in 1910, to 219,145 tons, valued at $10,293,400, in 1911.

### REVIEW BY COUNTIES.

*Pettis County.*—The Walsh Mining Co. on the Chester Realty Co.'s land in sec. 27, T. 44, R. 20, Pettis County, opened a new mine. The ore deposit is in limestone with a spar gangue, the lead content being greater than that of zinc. An 80-foot shaft was completed and a 200-ton concentrating plant was under construction.

*Benton County.*—The Tahoma Mining Co. operated a mine near Cole County during the first part of 1911 and recovered both galena and sphalerite concentrates. The deepest shaft on the property is down 225 feet, and the concentrating plant has a capacity of about 300 tons daily.

*Cole County.*—The Black Jack Mining Co. milled some ore in 1911, but none of the concentrates was sold. Much of the work was confined to experiments conducted with a view to obtain a process for cheap and clean separation of zinc blende from barytes. The

ore was hoisted through a 96-foot shaft and was milled at a plant having a capacity of 50 tons per 10-hour shift.

*Franklin County.*—The Wrisberg Mining & Milling Co. made no shipments of concentrates in 1911 pending the completion of a 100-ton concentrating plant which was expected to be ready for operation in May, 1912. The shaft is 100 feet in depth, and the ore body, apparently a crevice deposit, is reported to be developed for a distance of 600 feet both north and south from the shaft. A crosscut is reported to intersect another crevice deposit at a distance of 392 feet.

*Moniteau County.*—The Monarch Coal & Mineral Co., of Excelsior, worked a pocket of cannel coal, varying from 42 to 100 feet thick, by means of an open cut 95 feet in depth and a shaft 124 feet in depth. None of the lead concentrates and only a portion of the zinc concentrates incidentally recovered in the company's coal mining operation were shipped in 1911. Considerable lead and zinc is found chiefly in breccias adjacent to the coal and shale. The mineralized shale underlying the coal was not developed. Inadequate railroad facilities handicapped the coal output and restricted the production of lead and zinc. The company reports that the concentrating plant needs to be enlarged and remodeled to effect a better separation of the ore from the coal and shale gangue.

*Washington County.*—Several companies owning large tracts of land in Washington County, such as the Washington Land & Mining Co., the Southeast Missouri Lead Co., the Parole Mining & Mercantile Co. (successors to the Renault Lead Co.), and the Potosi Lead, Baryta & Mercantile Co. (formerly the Nina Realty Co.), work their property on a royalty basis. The ore which occurs at shallow depths and in association with barytes is mined in a small way and at odd times by the barytes miners. This ore is all hand picked and cleaned, there being no concentrating plants. There are numerous other shallow lead and barytes diggings scattered over Washington County which are worked by small operators and farmers who sell their product to the country merchants and to ore buyers. Much of this ore was purchased by James Long, of Potosi, and Higginbotham & Sons, of Fertile.

Bugg, Eversole & Towl, of Potosi, mined some galena through an 80-foot shaft. The Washington-Wayne Mining Co., leasing on the Flat River Mining Co.'s land, did considerable drilling with diamond and churn drills and sunk one shaft. Its output of lead concentrates in 1911, however, was obtained by surface mining.

*Jefferson County.*—The Valle Mining Co. also operates on a subleasing or royalty system a large tract of land in part in St. Francois County. The ores are galena and zinc carbonate and are found at depths ranging up to 225 feet, depending on the topography. Barytes (tiff) is also mined in small quantities. There were 12 shafts in operation in 1911, and a good production of ore was made. On the tract there is a Scotch hearth lead furnace which has not been operated for several years and a kiln in which the zinc carbonate ore is calcined before shipment. The preliminary prospecting with diamond drills was completed during the year, and new houses for employees and galvanized-iron sheds for the zinc kilns were built. A new shaft was sunk to a depth of 110 feet and the 5,000 acres of land was surveyed and platted.

The following section of drill hole No. 1, about three-fourths of a mile nearly due south of Valle mines station, as interpreted by the Missouri Bureau of Geology and Mines, has been furnished by the Valle Mining Co.:

*Section of drill hole No. 1, Valle mines, Jefferson County, Mo.*

| | Feet. |
|---|---|
| Surface | 9 |
| Potosi | 227 |
| Derby and Doe Run | 94 |
| Davis shale | 170 |
| Bonneterre | 240 |
| Total depth | 740 |

*St. Francois County.*—All the mines of the St. Joseph Lead Co. but one are located at Bonne Terre and Leadwood, the exception being shaft No. 8, which is near Flat River station. There were 9 shafts, averaging 365 feet, in operation in 1911, and the production was greater than ever before. These mines are all upon spurs of the Mississippi River & Bonne Terre Railway, a subsidiary organization, and are thus connected with the mills and the smelter of the company. The two concentrating plants, the Hoffman mill at Leadwood and the No. 1 mill or Bonne Terre mill, have a combined capacity of 3,000 tons of crude ore in 24 hours. The Hoffman mill is modern, but the No. 1 mill is of an older type and is equipped with Parsons and Harz jigs and percussion tables. The crushing department was electrified in 1910, and eventually the mill will be electrically driven throughout and otherwise remodeled by the substitution of Hancock jigs and Wilfley tables. The new producer-gas engine electric power and compressor plant is planned with space for the installation of sufficient equipment to drive the mines and mill from the central plant. Underground haulage is by means of compressed-air locomotives. A drift was started from the mine at No. 7 shaft, 1 mile southwest of Bonne Terre, to connect with the main underground workings at Bonne Terre, with the object of establishing underground haulage and abandoning the independent hoisting and pumping plant at No. 7. The smelter at Herculaneum, on the Mississippi River, near the northern terminus of the Mississippi River & Bonne Terre Railway, is equipped with 6 large Dwight & Lloyd sintering machines, 28 Savelsberg roasting and sintering pots, and 6 blast furnaces, with appropriate drossing kettles, etc.

The Doe Run Lead Co. operates 6 mines in the Flat River district, including No. 8 Mitchell shaft, about 3 miles west of Flat River, and No. 12 shaft (new), 2 miles south of Doe Run.

Of the 3 concentrating plants No. 1 mill at Doe Run (1,000 tons capacity), No. 2 Columbia mill (600 tons capacity), and No. 3 mill near Rivermines (2,000 tons capacity), No. 1 and No. 3 mills were operated during 1911. The latter is a modern mill in every respect and is built in 4 sections of 500 tons capacity each, which recently have been increased so that the mill can handle a total of 3,000 tons per 24 hours. The building is of steel construction throughout. All mill machinery is operated by alternating-current motors. The equipment consists of dry-crushing machinery, Hancock and Harz jigs, dry and wet rolls, Wilfley tables, Deister slime tables, and Frue vanners.

The mill receives its power from the central producer-gas power plant at Rivermines, which is a duplicate of the St. Joseph Lead Co.'s power plant at Bonne Terre, with the exception that the Rivermines plant lacks the gas-driven compressor. The equipment consists of 4 Snow twin tandem gas engines of 800 horsepower each direct connected to 600-kilowatt Westinghouse alternating-current generators. The producer plant contains 4 sets of Loomis-Pettibone generators, each of 1,000 horsepower capacity; also 2 sets of Westinghouse, continuous producers of 500 horsepower capacity each. The power plant also furnishes electric power to all the company shafts in the Flat River district for the operation of hoists, compressors, and underground pumps.

The underground haulage is performed partly by underground compressed-air locomotives and partly by mules.

No. 11 shaft, which was completed during the year, is held in reserve.

No. 12 shaft (2 miles south of Doe Run) was put into operation during April and supplies part of the ore milled in No. 1 mill. This shaft is equipped with electrically driven machinery, which receives current from the low-pressure steam turbo generator located at Doe Run.

The production of the Doe Run Lead Co. for the year 1911 was the largest in the history of the company, a total of 32,000 tons of metallic lead having been produced. A small quantity of copper concentrates were also recovered as middlings in concentrating the lead.

The Desloge Consolidated Lead Co. in 1911 operated 3 shafts, 2 of which are each 280 feet and the other 500 feet in depth. Two of the shafts are near the town of Desloge, but No. 4 shaft is near Leadwood. During 1910 the concentrating plant was remodeled and is now equipped with 3 Hancock jigs, 30 Wilfley tables, 10 Frue vanners, and appropriate rolls and Chile mills. The capacity is 1,500 tons per day of 24 hours. A large quantity of lead concentrates was produced, a portion of which was smelted in the company's smelter near the concentrating plant. The smelter is equipped with 4 Flintshire-Tarnowitz reverberatory furnaces, 2 hand rabbling reverbatory roasting furnaces, and 1 small cupola blast furnace, with drossing kettles, etc. In recent years none of the furnaces, except 2 of the Flintshire furnaces, has been worked, the "gray" slag being sold to other smelters.

The St. Louis Smelting & Refining Co. has its mines in the vicinity of the village of St. Francois, about 1 mile north of Flat River. Four shafts, ranging from 200 feet to 560 feet in depth, were in operation in 1911. Shaft No. 6, one-fourth of a mile west of Flat River, was sunk during 1910 and put in operation in 1911. The bottom of the ore was reached at 540 feet and the Lamotte sandstone at 560 feet. The concentrating plant is modern, having a capacity of 1,600 tons per day of 24 hours and being equipped with Hancock jigs, Richards classifiers, Huntington mills, Overstrom and canvas tables, Frue vanners, slime and settling tanks. A central steam-power plant drives air compressors and electric generators. The mill, hoists, and pumps are operated by electricity, as well as the underground haulage and the electric trams for handling the ore from the shafts to the mill. This company also operates a lead

smelter and refinery at Collinsville, and the lead concentrates produced by the mines were smelted at that plant.

The Federal Lead Co. operated 3 shafts during 1911. These mines are in the vicinity of Flat River, Central, and Elvins. The average depth of mining is about 415 feet. A large increase was made in the production of lead concentrates in 1911. There are 2 concentrating plants, one of 800 tons and the other of 3,600 tons rated capacity, but really developing 4,000 tons capacity per day of 24 hours. The smaller mill was idle in 1911, but the larger one was operated continuously. It is of best modern type, with a full complement of crushing machinery, Hancock jigs, Richards classifiers, Wilfley tables, Frue vanners, and slime separators. These are arranged in 6 units. Separate from the mill there is a series of slime settling tanks, the pulp from which is treated on canvas slime tables. Power for mining and milling is furnished from a central power plant which adjoins the large mill, and is equipped with water-cooled steam-turbine-driven electrical generators. Electrical haulage is installed underground.

The Potosi Mining Co., which had an option to purchase the Jake Day tract of 358 acres at Leadwood, after drilling the property with core drills and sinking the Alma shaft transferred its interest to the St. Louis Smelting & Refining Co. Drilling operations were continued, but apparently the option to purchase was not exercised in 1911.

*Madison County.*—The Mine La Motte Lead & Smelting Co. operated 3 shafts during 1911 on a tract which was first mined in 1720. The shallow deposits which were first worked were followed down to a depth of 100 to 125 feet, from which level the ore has been coming, which for 50 years has supplied the mill and smelter. The mill, which is practically new, has a capacity of 500 tons per day of 24 hours. The old 250-ton mill and the 400-ton mill of the Wheeling Milling Co., on the same tract, were not in operation. The smelter has likewise been idle for several years. The attempt was made some years ago to smelt the copper and nickel-cobalt sulphides, which in certain parts of the mines occur plentifully with the lead and are separated in concentration. Of late years these ores have been avoided and attention in mining has been limited to the lead ores. The lead smelter has not been operated for several years.

The Catherine mine, formerly owned by the Madison Lead & Land Co., was leased by the Federal Lead Co. from the Phoenix Lead Co. The only work done in 1911 was prospecting by means of diamond drills.

The mine was formerly worked from two shafts, 130 and 160 feet in depth, respectively. There are two mills, an older 200-ton mill located on Little St. Francois River and connected with the mine by a long aerial tramway, and a newer 500-ton mill located at the mine. A peculiarity of the mine has been the occurrence of huge mud pockets which, when broken into, flow out into the mine and fill the drifts. Litigation prevented the resumption of work at the North American mine, which was bought in by the Canadian bondholders. The ore formerly mined consists of an intimate mixture of the sulphides of copper, lead, nickel, cobalt, and iron in the form of chalcopyrite, galena, limonite, and pyrite. As reported by

the receiver of the property, the metals have the following proportions in the ore: Copper, 2.5 per cent; lead, 2 per cent; nickel, 1 per cent; and cobalt, 0.5 per cent; in all, 6 per cent of metallic content.

## OKLAHOMA.

By J. P. Dunlop.

### PRODUCTION.

The production of lead and zinc in Oklahoma in 1911 is shown in the following table:

*Production of lead and zinc in Oklahoma in 1911, by districts, in short tons.*[a]

| District. | Ores. | | | | | | | | Metal content. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lead concentrates. | | | | Zinc concentrates. | | | | Lead. | | Zinc. | |
| | Galena. | | Carbonate. | | Sphalerite. | | Carbonate and silicate. | | Quantity. | Value. | Quantity. | Value. |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | | | | |
| Ottawa County: | | | | | | | | | | | | |
| Miami | 2,848 | $152,527 | | | 8,391 | $247,530 | | | 2,230 | $200,700 | 3,809 | $434,226 |
| Peoria | 12 | 628 | | | | | 311 | $8,330 | 10 | 900 | 116 | 13,224 |
| Quapaw | 329 | 18,202 | | | 2,245 | 82,571 | 6 | 85 | 261 | 23,490 | 1,154 | 131,556 |
| Total | 3,189 | 171,357 | | | 10,636 | 330,101 | 317 | 8,415 | 2,501 | 225,090 | 5,079 | 579,006 |
| Murray County | | | | | 25 | 842 | 195 | 2,801 | | | 71 | 8,094 |
| State total: | | | | | | | | | | | | |
| 1911 | 3,189 | 171,357 | | | 10,661 | 330,943 | 512 | 11,216 | 2,501 | 225,090 | 5,150 | 587,100 |
| 1910 | 3,637 | 188,021 | 1 | $42 | 13,976 | 447,043 | 280 | 5,572 | 2,888 | 254,144 | 6,394 | 690,552 |
| 1909 | 4,306 | 223,377 | | | 16,584 | 568,614 | 453 | 10,627 | 3,427 | 294,722 | 7,806 | 843,048 |
| 1908 | 2,236 | 118,333 | | | 10,038 | 249,991 | 280 | 6,625 | 1,781 | 149,604 | 4,529 | 425,726 |
| 1907 | 662 | 44,771 | 5 | 275 | 3,076 | 119,008 | 650 | 15,667 | 532 | 56,392 | 1,657 | 195,526 |

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses in case of zinc, but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York.

The following table gives the crude lead and zinc ore for the whole State of Oklahoma, but it was thought advisable to calculate the tenor of crude ore and concentrates as well as assay content and value of concentrates separately for the Miami and the Quapaw districts, inasmuch as the character of the ground operated in these districts differs so radically that general calculations for the State would be valueless:

*Tenor of lead and zinc ore and concentrates produced in Oklahoma, 1910 and 1911.*

| | 1910 | 1911 |
|---|---|---|
| Total crude ore.....short tons.. | 223,212 | 224,450 |
| Miami district: | | |
| Total concentrates in crude ore— | | |
| Lead.....per cent.. | 2.9 | 2.0 |
| Zinc.....do.... | 8.9 | 5.6 |
| Metal content of crude ore— | | |
| Lead.....do.... | 2.4 | 1.5 |
| Zinc.....do.... | 4.3 | 2.8 |

*Tenor of lead and zinc ore and concentrates produced in Oklahoma, 1910 and 1911*—Continued.

| | 1910 | 1911 |
|---|---|---|
| Miami district—Continued. | | |
| Average lead content of galena concentrates.....per cent.. | 79.5 | 78.3 |
| Average zinc content of sphalerite concentrates.....do.... | 48.7 | 50.4 |
| Average value per ton of galena concentrates..... | $51.76 | $53.55 |
| Average value per ton of sphalerite concentrates..... | $29.32 | $29.50 |
| Quapaw district: | | |
| Total concentrates in crude ore— | | |
| Lead.....per cent.. | .3 | .4 |
| Zinc.....do.... | 3.7 | 3.0 |
| Metal content of crude ore— | | |
| Lead.....do.... | .2 | .3 |
| Zinc.....do.... | 2.2 | 1.7 |
| Average lead content of galena concentrates.....do.... | 78.2 | 79.3 |
| Average zinc content of sphalerite concentrates.....do.... | 57.9 | 57.0 |
| Average value per ton of galena concentrates..... | $50.84 | $55.32 |
| Average value per ton of sphalerite concentrates..... | $38.81 | $36.78 |

In 1911 the lead concentrates produced in the Oklahoma districts were of about the same grade as those shipped in 1910. The average selling price of lead concentrates was $1.79 per ton higher at Miami and $1.48 per ton higher at Quapaw than in 1910. Both the tonnage of ore milled and the average concentrates contained in the crude ore declined in the Quapaw district. The blende concentrates in the Miami district contained 1.7 per cent more zinc content in 1911 than in 1910, but the metal of the zinc blende concentrates from the Quapaw district was 0.7 per cent lower than it was in 1910.

The shipments of both lead and zinc concentrates from Oklahoma were less in 1911 than in 1910. The lead concentrates sold were 448 tons less in quantity and $16,664 less in value than in 1910. The shipments of sphalerite or blende concentrates were 3,315 tons less in quantity and $116,100 less in value.

The shipment of zinc carbonate increased from 280 tons to 512 tons, and the value was $5,644 more than in 1910.

The entire output of lead concentrates and all but 25 tons of sphalerite concentrates came from Ottawa County. About 60 per cent of the zinc carbonate concentrates were derived from Ottawa County and the remainder from Murray County.

The Miami district yielded 78.7 per cent of the sphalerite concentrates and 89 per cent of the galena concentrates sold in Oklahoma in 1911.

## NORTHEAST OKLAHOMA.

The lead and zinc mines of this section form the southwesternmost extension of the ore deposits of the Joplin region. They occur chiefly in chert breccias, but occasionally in limestone and sandstone breccias. The sandstones belong to the Chester group, the cherts to the Boone formation, and the limestones to either the one or the other, both being of lower Carboniferous age. The ores are galena, sphalerite or zinc blende, and zinc carbonate and silicate. The galena is practically nonargentiferous, never containing as much as an ounce of silver to the ton of lead concentrates.

*Peoria district.*—There was very little mining at Peoria, the site of the first lead and zinc mining in Oklahoma, until nearly the end of 1911. The high price then offered for zinc carbonate ores induced

more active operations, and the output of concentrates increased during November and December. No sphalerite was shipped and only a small quantity of galena, but the output of zinc carbonate ores increased from 65 tons in 1910 to 311 tons in 1911. The ore was obtained from shallow shafts on the Scott and the Heling lands by C. C. Geboe, Pool & Shaler, Kellar Bros., Webb & Co., and Summers & Co.

*Quapaw district.*—The low prices paid for concentrates in the early part of 1911 tended to restrict production and development in this district. Most of the larger mining companies operate on blanket ground yielding about 3 per cent of concentrates. Many of the mines were not operated, and others were only worked a portion of the time.

The production of lead concentrates was 59 tons larger than in 1910, but the shipment of sphalerite declined 1,676 tons. The production of zinc blende concentrates was 2,245 tons, a decrease of 40 per cent when compared with the output of 1910 and of about 55 per cent when compared with that of 1909. The higher ore prices prevailing at the end of the year will probably result in an increased output in 1912.

The White Eagle mine, which has a milling plant capable of treating 250 tons of ore daily and which was the largest producer in 1910, reported no output for 1911.

The Petersburg Land & Mining Co., with a 1,000-ton (per 24 hours) concentrating plant erected in 1911, although not working steadily, produced more sphalerite concentrates than any other property.

The Mission mine produced two-thirds of all the lead shipped in 1911 and was second in the production of sphalerite. The ore in this mine was hoisted by means of four shafts from about the 70-foot level. The property is equipped with a mill of large capacity.

The lessees on the land of the Iowa & Oklahoma Mining Co. who produced concentrates were C. Ed. Miller, the Good Luck Mining Co., and the Katy Lee Mining Co. Four shafts were in operation, and ore was extracted from levels at depths ranging from 62 to 140 feet. A 100-ton mill and hand jigs were operated by the lessees. A deficient supply of water hampered work for part of the year; this reduced the output but resulted in more extensive development work on the Good Luck lease.

The Big Jack mine was operated part of the year by lessees and made some shipments of both lead and zinc concentrates.

Other mines having a small production or doing development work were the Alabama, Joanna, Heap-O'Brien, Mason, and McAllister.

*Miami district.*—The mines of the Miami district in 1911 shipped 2,848 tons of galena concentrates, valued at $152,527, and 8,391 tons of sphalerite concentrates, valued at $247,530. This shows a decrease of 516 tons of galena concentrates and of 1,664 tons of sphalerite concentrates when compared with the output of 1910. The total decrease in the value of the concentrates was $68,954. The district still maintained a high ratio of concentrates from the crude ore milled. The average of the metal content of the blende concentrates produced showed a slight increase, and the selling price of both the galena and blende concentrates increased over that of 1910.

The ores are galena and sphalerite in about the proportion of one of the former to three of the latter, no oxidized ores having yet been found. The upper run of ores as worked in previous years occurs at a depth of 90 to 130 feet in sandstone breccias and in flint breccias lying below the sandstone; but as this run is followed to the north it rapidly descends and in recent openings is from 230 to 250 feet in depth. The sandstone is impregnated with a heavy oil, which, evaporating to asphalt, causes much trouble in saving the concentrates in that it balls up the ores on the jig beds and tends to float off the finer particles of ore. It also has a tendency to lower the grade of the concentrates by enveloping them in films of carbonaceous matter and so causing finely powdered marcasite and pyrite to stick to them.

The main ore body so far worked has the form of a long straight run, bearing about N. 30° W. and reaching from the Sunny Jim mine at the southeast to the Emma Gordon mine on the northwest, a distance of 4,300 feet, and shown by the drill to extend at least 2,500 feet in a more northerly direction beyond the Emma Gordon mine, a total known length of about 1¼ miles. Throughout this distance the ore body is in a sandstone breccia, with shale overlying. At places in the run stopes have been taken up in the underlying chert breccia. The width of the run varies from 75 to 150 feet and the height from 8 to 13 feet, ranging up to 25 feet where the lower stopes have been taken up. Several other ore bodies have been opened to the west of this run which have their elongation parallel to the run, but none of these as at present developed are at all comparable to the main run in extent. Although the production of the district was less than in 1910, development was very active over the entire camp. Drilling on the lands of the Emma Gordon Mining Co. and the Miami Royalty Co. indicated large bodies of ore at lower levels than any heretofore mined. Systematic drilling was undertaken by many lessees on proved and outside leases, and shafts were sunk by some of the lessees. The principal difficulty encountered was the heavy volume of water which seriously impeded the sinking of new shafts. In order to continue development it was necessary to install pumps of large capacity. By reason of this condition the shipments of concentrates derived from the deep runs of ore were limited in 1911 to a small quantity milled by the Oklahoma Lead & Zinc Mining Co. for the Carson Dodson Mining Co. This company had two shafts down 232 feet on the Emma Gordon land.

The development of the Miami mines has been toward the north. The earlier production came from the southern portion of the district from ore bodies from 90 to 130 feet in depth. The drilling in 1911 showed ore bodies as deep as the 300-foot level. The result of the drilling also stimulated operations at the old mines in the southern part of the district, making Miami at the end of 1911 one of the most active districts in the Central States.

The four largest shippers of lead and zinc concentrates in 1912 were the Miami Amalgamated Mining Co. (Sullivan lease), Turkey Fat Mining Co., and Kansas Mining Co. (New State), all on the Miami Royalty Co.'s leasehold, and the Standifer Mining Co., on the Emma Gordon Mines Co.'s lease. The 1911 producers on the Emma Gordon lease were the Standifer Mining Co., operating four shafts, the High Five Mining Co., and the Carson Dodson Mining Co.

The Oklahoma Lead & Zinc Co. erected a new mill on the Church-Mabon lease of the Emma Gordon, and the Prairie Mining Co. and Thirty Aces Mining Co. were engaged in developing and shaft sinking.

Chapman & Lennan subleased portions of both the Emma Gordon and the Miami Royalty land and moved the Red Dog mill from Webb City, Mo., to the Miami Royalty Co.'s land.

In addition to the Sullivan and the Turkey Fat mines, the Buckeye, the Index, and the Old Chief, subleases of the Miami Royalty Co., all made good shipments of concentrates.

The Kansas Mining Co. operated a 100-ton mill and located a lower run of ore at 180 feet, which will be developed in 1912.

The Buckeye mine was operated by the Queen City-Joplin Mining Co., and the Old Chief mine was acquired by Standifer Bros. Both mines will be more actively worked in 1912.

On the Baxter Royalty Co.'s leases production was made by the following mines during 1911: The Golden Hen, Little Maxine, and Old Crescent. The Midas Mining Co., on the Nelson land, was also a producer in 1911.

### ARBUCKLE MOUNTAIN REGION.

In the southern part of Oklahoma prospecting for lead and zinc has been prosecuted in the neighborhood of Ravia, at the southeast end of the Arbuckle Mountains, and in Murray County, 8 miles southwest of Davis, near the northwest end of the same range, the last-mentioned locality having become productive in 1909. The Arbuckle Mountains consist of a core of pre-Cambrian granites and diabases overlain by the Reagan sandstone, a basal conglomerate formation of Upper Cambrian age, and that in turn by the Arbuckle limestone, of Cambrian and Ordovician age, followed by the other formations exhibited by the Paleozoic in that province. The whole uplift is greatly faulted and, especially in the mining district southwest of Davis, is sharply folded. The ore deposits in the Davis area are found in the dolomitic Arbuckle limestone, generally in clay-filled solution channels. All the ore shipped in 1910 was zinc carbonate from open pits and very shallow shafts. A few shafts are reported to reach a depth of 40 and 60 feet and to have developed deposits of zinc blende. In 1911 there were 25 tons of sphalerite and 195 tons of zinc carbonate concentrates shipped from the Davis field, which was slightly more than in 1910.

One 45-ton mill was operated by the United Mining & Milling Co. on the Sober-Hope land, and additional mills were reported contracted for. Extremely dry weather, high prices paid for fuel, and lack of adequate transportation were the principal causes of the small output.

H. E. Pegan also shipped some zinc carbonate concentrates, averaging 33 per cent metal content, from shallow workings on the Warren land. Some development work was done by S. H. Ballard near Ravia, but the only shipments were crude ore for testing.

The following description of the region is taken from an article by L. C. Snider, assistant director of the Oklahoma Geological Survey, entitled "The Davis Oklahoma zinc field," published in the Mining and Scientific Press, September 2, 1911:

In the heart of the Arbuckle Mountains, 7 miles southwest of Davis, Okla., is a zinc field which has recently shown promise of development. The productive horizon is a dolomitic member in the lower part of the Arbuckle limestone. The dolomitic outcrops from northwest to southeast along the northeast side of two large granite porphyry hills, known as East and West Timbered Hills. The belt has a length of 15 miles and an average width of less than one-half mile. The porphyry and dolomite are separated by the Reagan sandstone, of Middle Cambrian age, and the lowest portion of the Arbuckle limestone, which is a dense, thin-bedded blue-gray limestone. The limestone above the dolomite is similar to that below, except that the layers are much thicker. Locally at least there is an intraformational limestone conglomerate at the top of the dolomite. The limestones and dolomite dip steeply to the northeast away from the granite porphyry. The average dip is between 40° and 50°, but there is much variation due to minor folding and to faulting. Many small faults almost perpendicular to the strike cross the outcrop of the dolomite. The lateral displacement due to these faults varies from a few feet to 20 rods. In every case the northernmost block is displaced to the east. All the rocks are much broken by jointing, but this is especially true of the dolomite. A sharp blow of the hammer breaks a large block into small angular fragments, few of which are over 1 inch in any dimension. The concentration of the zinc in the dolomite is probably due to this broken condition, the small seams forming channels for the passage of circulating waters carrying zinc in solution and at the same time affording small cavities for the deposition of the ore.

It is claimed by the prospectors and others interested that all the dolomite area contains rich ore, but from the present development this is only proved in a limited portion of the belt lying in secs. 17, 18, and 21, in T. 1 S., R. 1 E. Here the zinc ore occurs as the carbonate from the surface to a depth of 5 to 8 feet. Below this level the zinc is in the form of sulphide or zinc blende. The carbonate contains large proportions of dolomite. The blende is usually finely disseminated, but in some cases seems to have largely replaced the country rock, so that the blende makes up the larger portion of some of the strata. The two most important mines that have been opened show two layers of the blende-bearing rock, each 3 to 4 feet thick, separated by a layer of "dead rock" 5 to 6 feet thick, carrying only thin seams of blende. A well being drilled on one of the properties is said to have shown the rich ore to a depth of 30 feet and to have penetrated a similar body at 125 feet below the surface. * * * The concentrate from the only mill which has been built shows 45.96 per cent. The mill was not run long enough to get the crushing machinery and tables properly adjusted, so that the showing of the concentrate is probably not so good as can be obtained. Much higher values than those shown by these analyses are reported by others, and for that reason it is judged best not to give the exact location of the samples until a larger number can be collected and analyzed.

Pyrite and marcasite are practically absent from the zinc blende in the body of ore near the surface. The cuttings from the deep body found in the well previously mentioned show some pyrite, but it is apparently in small quantity. Lead occurs in small quantity near the surface as the sulphide and as the carbonate. Copper stains are often present, and some pieces of malachite and azurite have been discovered in different parts of the field. So far no large body of copper ore is known to have been found, although there are rumors to the effect that such bodies exist.

The principal development so far consists in small openings or prospects. One company has a mill with four concentrating tables. The mill was run less than one day before the water supply was exhausted, consequently little can be said of the milling properties of the ore except that fine grinding is necessary to insure complete separation. A well is being drilled at this mill in the hope of securing a permanent water supply. Three other companies have boilers on the ground and mills ordered. One of these companies has a core-drill outfit ordered and plans to prospect thoroughly for deep-seated ore. Several carloads of carbonate ore have been shipped from the field. This is reported to have paid fairly well. One or two carloads of sulphide ore has been shipped, but the results could not be learned.

## WISCONSIN.

By J. P. Dunlop.

### PRODUCTION.

The production of lead and zinc in Wisconsin in 1911 is shown in the following table:

*Production of lead and zinc in Wisconsin in 1911, by districts, in short tons.*[a]

| District. | Ore. | | | | | | Metal content. | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lead concentrates. | | Zinc concentrates. | | | | | | | |
| | Galena. | | Sphalerite. | | Carbonate. | | Lead. | | Zinc. | |
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Benton | 991 | $52,985 | 32,453 | $546,872 | 131 | $2,454 | 779 | $70,110 | 8,292 | $945,288 |
| Cuba City-Elmo | 601 | 32,375 | 2,185 | 52,909 | ..... | ..... | 483 | 43,470 | 773 | 88,122 |
| Dodgeville | 70 | 3,880 | 263 | 7,084 | 60 | 1,080 | 60 | 5,400 | 126 | 14,364 |
| Hazel Green | 547 | 25,405 | 20,632 | 417,098 | ..... | ..... | 380 | 34,200 | 6,360 | 718,200 |
| Highland | 206 | 11,108 | 81 | 3,013 | 4,784 | 69,235 | 150 | 13,500 | 1,273 | 145,122 |
| Linden | 205 | 10,286 | 8,317 | 124,487 | ..... | ..... | 154 | 13,860 | 1,923 | 219,222 |
| Livingstone | 181 | 8,365 | 7,987 | 155,497 | ..... | ..... | 129 | 11,610 | 2,410 | 274,740 |
| Mifflin | 477 | 27,507 | 6,720 | 181,882 | ..... | ..... | 378 | 34,020 | 2,569 | 292,866 |
| Mineral Point | 40 | 2,000 | 684 | 9,614 | ..... | ..... | 30 | 2,700 | 167 | 19,038 |
| Montfort | 155 | 8,228 | 1,567 | 28,528 | ..... | ..... | 118 | 10,620 | 452 | 51,528 |
| Platteville | 268 | 13,288 | 12,748 | 395,425 | ..... | ..... | 200 | 18,000 | 5,338 | 608,532 |
| Shullsburg | 618 | 34,038 | 326 | 6,714 | 60 | 1,374 | 492 | 44,280 | 97 | 11,058 |
| State total | 4,359 | 229,465 | 93,963 | 1,929,123 | 5,035 | 74,143 | 3,353 | 301,770 | 29,720 | 3,388,080 |
| 1910 | 5,608 | 286,493 | 89,232 | 1,750,574 | 5,269 | 69,588 | 4,413 | 388,344 | 25,927 | 2,800,116 |
| 1909 | 4,659 | 254,514 | 65,421 | 1,505,752 | 5,130 | 63,603 | 3,694 | 317,684 | 23,152 | 2,500,416 |

[a] In calculating the metal content of the ores from assays allowance has been made for smelting and separating losses in case of zinc, but not in case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer and that the value of the metal is calculated from the average daily quotations at New York and St. Louis.

*Tenor of lead and zinc ore and concentrates produced in Wisconsin, 1910 and 1911.*

| | 1910 | 1911 |
|---|---|---|
| Total crude ore, short tons | 1,032,052 | 1,123,040 |
| Total concentrates in crude ore: | | |
| Lead, per cent | 0.5 | 0.4 |
| Zinc, do | 9.2 | 8.8 |
| Metal content: | | |
| Lead, do | .4 | .3 |
| Zinc, do | 3.2 | 3.1 |
| Average lead content, do | 78.7 | 76.9 |
| Average zinc content of sphalerite concentrates, do | 34.8 | 37.2 |
| Average zinc content of zinc carbonate concentrates, do | 29.9 | 33.1 |
| Average value per ton of lead concentrates | $51.09 | $52.41 |
| Average value per ton of sphalerite concentrates | $19.62 | $20.53 |
| Average value per ton of zinc carbonate concentrates | $13.21 | $14.72 |

The lead and zinc mines of Wisconsin are in Grant, Iowa, and Lafayette counties and comprise the most important part of the ore deposits of the upper Mississippi Valley region. The ore deposits occur in the galena dolomite and in the upper part of the Platteville limestone, both of Ordovician age. The ores are galena, sphalerite

or zinc blende, and smithsonite or zinc carbonate, the latter locally known as "dry bone." As a lead region the district has been known from the earliest settlement days. In time the building of smelters near by made a market for the zinc ores. The first zinc ore to be mined was the carbonate found in association with lead in the shallow working above ground-water level. When all the main deposits were worked out down to water level there was a lull in mining in the region. Though the carbonate was known to give place to zinc blende and the lead to continue on below water, it was not deemed profitable to mine when continued pumping was necessary. About 8 or 10 years ago the higher price of zinc led to the opening of some of the deposits below water level, since which time zinc mining has increased until Wisconsin in 1911 stood third in rank among zinc-producing States. The ore bodies are found in perpendicular, horizontal, or inclined cavities known as "openings" or "crevices," "flats," and "pitches." These openings sometimes extend for considerable distance in a straight line called a "range" and may be operated at different places by different companies. When a range is once established it becomes an important guide in prospecting.

The galena of the district is nonargentiferous, and so far as known the zinc ores are free from cadmium. In some of the mines marcasite is so plentiful that the zinc blende concentrates are reduced to a very low grade. Owing to their nearness in specific gravity, marcasite and blende are very difficult to separate cleanly by hydraulic methods. Both electrostatic and electromagnetic separation processes are in operation.

A small number of the concentrating plants in the district are equipped with roasters and magnetic separators. Some mining companies having such equipment did not operate it, and many of the companies constructing milling plants in 1911 did not report the erection of roasters. It is believed by many mine owners that it is more economical to sell the green concentrates than to invest in a roasting plant, entailing the employment of extra shifts of men during the entire day of 24 hours.

The Galena, Ill., plant of the Joplin Separating Co., which makes a business of separating low-grade blende-marcasite ores, was destroyed by fire in the latter part of 1911, but has been reconstructed on a larger scale. The Mineral Point Zinc Co. operates a roaster and magnetic separator at Mineral Point, Wis., and green concentrates were treated by the Wisconsin Separating Co. at Benton, the National Zinc Separating Co. at Hazel Green, and the Campbell Magnetic Separating Co. at Cuba City. The last-named company uses a patented process, which requires the ore to be only slightly roasted and which recovers the marcasite and pyrite in shape for sale to acid manufacturers.

At the other four plants the concentrates, after being dried, are roasted, the customary form of roaster being a long, slowly revolving cylinder lined with fire brick. The roasting is carried far enough to render the marcasite magnetic, but not to drive off all the sulphur, after which the concentrates are passed under a magnetic separator, which removes the iron.

The plant of the American Zinc Ore Separating Co., of Platteville, which was equipped with driers and both Blake-Morscher and Huff electrostatic separating machines, was destroyed by fire in

October, 1911. The capacity of the burned plant was 100 tons a day. The multiplication of individual and custom roasters, by raising the low-grade ore to high grade, will have a tendency to reduce relatively the tonnage of zinc concentrates, though, of course, the metal content and the value will be less affected; hence these must serve as the basis of comparison for different years.

About 55 per cent of the sphalerite concentrates shipped in 1911 went to the separating companies. The quantity of roasted concentrates sold by the mining companies was small when compared with the aggregate shipments. The only roasters and separating plants installed in 1911 by mining companies were those of the Peaceful Valley Mining Co., at Cuba City, and the Wisconsin Zinc Mining Co., at Hazel Green. Some high-grade green concentrates were produced. The average zinc content of the sphalerite concentrates sold in 1910 was 34.8 per cent, and the average price per ton was $19.62; the corresponding content and price for 1911 were 37.2 per cent and $20.53.

Milling practice is much as in the Joplin region, except that in Wisconsin everything is on a smaller scale. The mills of 100 tons or over, with rougher, cleaner, sand jigs, and concentrating tables, have generally been built in the last few years. There were about 50 new concentrating plants erected in 1907, many of them being of the larger size. Mill construction was naturally much less active in the following years.

The mills built in 1911 with their reported capacity and location were the following: Murray Mining Co., 25 tons; New Eureka Mining Co., 20 tons; Vinegar Hill Zinc Co. (Wilkinson mine), 100 tons; Vinegar Hill Zinc Co. (Rowley mine), 75 tons, at Benton; Mineral Point Zinc Co. (Coker mine), 125 tons, at Livingston; Milwaukee-Shullsburg Mining Co., 50 tons, at Shullsburg.

In addition to the burning of the separators at Galena, Ill., and Platteville, Wis., several of the larger concentrating plants in active operation were destroyed by fire during the last six months of the year. Although these losses may have been accidental, there are many operators who took extra precaution to protect their plants from incendiarism.

The crude ore yields from 5 to more than 20 per cent of zinc concentrates, and the building contracts in the case of the larger mills generally call for a saving of 85 per cent of the blende in the crude ore, but very likely in practice this figure is not nearly attained. The mining methods are largely determined by the mode of occurrence of the ores, but otherwise are similar to those in vogue in working the pockety ores at Joplin.

The zinc carbonate ore, which is mined principally in the Highland district, is chiefly purchased by the Mineral Point Zinc Co. and made into zinc oxide in the plant at Mineral Point, Wis. A considerable quantity of the low-grade zinc blende concentrate is used in the same way.

The value of the mine output of lead and zinc in the year 1911 was $3,689,850, against $3,188,460 in 1910, so that the increase was $501,390. The average metal content of the galena concentrates was slightly lower than in 1910, and that of the sphalerite concentrates was 2.4 per cent higher. The price per ton received for galena con-

centrates was $1.32, and for sphalerite concentrates $0.91, more than in 1910, and the total value of the concentrates sold increased $126,076.

The galena shipments sold declined from 5,608 tons, valued at $286,493, in 1910, to 4,359 tons, valued at $229,465, in 1911, and the metal content in 1911 was 1,060 tons less than in 1910. The Benton district produced the largest quantity of galena shipped, with Shullsburg district (where the "dirt" milled yielded about 3 tons of galena to 1 ton of sphalerite) in second place, and Cuba City the third largest producer. These three districts shipped over one-half of the galena concentrates sold in Wisconsin in 1911. The output of zinc carbonate concentrates was 234 tons less than in 1910, but the value, owing to an increase of $1.51 per ton, was $4,555 more than in 1910.

The mines of the Highland district contributed 95 per cent of the production of zinc carbonate, as compared with 97 per cent in 1910.

The total estimated tons of crude ore treated by concentrating plants increased from 1,032,052 tons in 1910 to 1,123,040 tons in 1911, but the concentrates in crude ore declined from 9.7 per cent to 9.2 per cent, and the metal content of these concentrates declined from 3.6 per cent to 3.4 per cent. These figures indicate no great variation in the quality of the ore hoisted or in the mill treatment from the conditions prevailing in 1910. The metal content of the sphalerite sold varied from 14 per cent to 58.9 per cent, and the larger portion of the concentrates sold ranged between 28 and 40 per cent. The large companies continued to add to their holdings by purchase and lease, and most of the increased output was due to their operations. The area of the mining territory was not expanded materially, though prospect drilling was more active than in 1910.

### REVIEW BY DISTRICTS.

*Benton district.*—This district produced about 23 per cent of the galena concentrates and 34 per cent of the sphalerite concentrates sold in Wisconsin in 1911. The production increased about 30 per cent and was very much larger than that of any other Wisconsin district. The increase was mainly due to much more extended operations of the Frontier Mining Co., the Wisconsin Zinc Co., the Vinegar Hill Zinc Co., and the Mineral Point Zinc Co. The Frontier Mining Co., in addition to making a very large production of sphalerite from the ore treated at the 75-ton mill, developed the Sedgewick mine and the Hird lease.

The Wisconsin Zinc Co. operated the Winskill and Drum mines. The Winskill had a large output, its production of lead being larger than that of any other mine in the district. The shaft is 130 feet deep and the property is equipped with a 100-ton (10-hour shift) mill, driven by electric power. The Drum mine, which has a shaft 120 feet deep, was only worked during the first half of 1911, and the lease was then prospected by churn drills.

The Mineral Point Zinc Co., after operating the concentrating plant at the Ollie Belle mine, east of Benton, for a brief period, dismantled the mill. The Fox mine, which was purchased by the Mineral Point Zinc Co., was a large shipper of sphalerite, and the mine workings were further developed and the equipment improved. The shaft at the mine is 145 feet deep and the concentrating plant has a

capacity of 100 tons per 10-hour shift. The Lucky Twelve Mining Co., located on the Murphy land, was one of the largest producers of sphalerite concentrates in the State. The shaft at this mine is 125 feet deep and the mill has a capacity of 200 tons per 12 hours.

The Vinegar Hill Zinc Co. operated the Wilkinson and Rowley mines and made a considerable production. The Wilkinson mine shaft was down 90 feet and a new electrically-driven concentrating plant of 100 tons (10-hour shift) capacity was erected. The Rowley mine on the Gillette land was equipped with a 75-ton plant, which was also operated by electric power. The Sheffer Mining Co. worked the Pittsburg-Benton mine for a portion of the year, producing both lead and zinc concentrates.

The Ewing Mining Co. operated the Etna mine by means of a 83-foot shaft and recovered a fair output of concentrates from ore treated at the 150-ton mill.

The Field Mining Co.'s production was not nearly as large as in the year 1910. The company added 200 acres to the leasehold and kept 2 prospect drills running. The shaft was sunk deeper, new electric and steam pumps were installed, and other improvements were made which will greatly increase the 1912 production.

The Calvert mine was worked only during the first few months of 1911 and in consequence the output was much less than in 1910.

The New Eureka Mining Co., on the Champion Mining Co.'s land, extracted ore by means of a tunnel and built a small mill which turned out a fair output of concentrates.

The Minnie Mining Co., on the Cottingham land, was one of the largest producers of galena concentrates in the district and also shipped some low-grade sphalerite.

One of the new producers in 1911 was the Murray Mining Co., on the McCabe land. The ore was hoisted from an average depth of 90 feet and milled on a 25-ton concentrator. Other producing mines in 1911 were the Monarch, Schreier, Julian, and Little Bennie. The Badger Zinc Co., Garden City Mining Co., Mack Mining Co., New Quinlan Mining Co., and the McCabe Mining Co. were all doing development work, and Longhenry Bros. were drilling the Spenceley land.

*Cuba City-Elmo district.*—The production of lead concentrates in 1911 in this district was much less than in 1910 and the output of sphalerite was only about one-third of that of 1910. The Board of Trade Mining Co., on the Byrne land, was the largest producer of concentrates in the district, although the mine and 250-ton mill were not in operation the last four months of 1911.

The Peaceful Valley Mining Co., on the Kettler land, hoisted ore through No. 1 shaft 100 feet deep and began sinking another shaft. The company added a roaster and other mine and mill equipment, all of which was electrically driven. The concentrates shipped were galena and green and roasted sphalerite of high metallic content. The iron sulphide deposit located in 1910 was further explored and was found to be of large extent and some shipments of 40 per cent pyrite were made to acid manufacturers.

The Jarrett mine, on the Banfield land, was operated under lease by the M. & D. Mining Co. The quantity of ore or "dirt" milled at the 200-ton concentrating plant was small, but the percentage of

concentrates recovered was large, especially of galena. New pumps, an air compressor, and other mine and mill equipment were added to the plant. The property was well prospected and the output would have been much larger if an excess of water had not retarded operations.

The Best mine was idle during the year, and the Henrietta shipped only galena concentrates milled in 1910. Development work only was done at the Laurence mine and the work of unwatering the Vanderventer mine was not commenced until December. The Vanderventer has a concentrator of 50 tons capacity and a roasting and separating plant of 20 tons capacity per day. The Raisbeck land was taken over by the Vinegar Hill Zinc Co. and after being drilled a 90-foot shaft was sunk and the property brought to a producing stage. A concentrating plant will be erected in 1912. The only producer in the Elmo district was the Beloit Leasing Co., operating the Beloit-Elmo mine. Most of the year was occupied with development work. The ore that was hoisted came from the 125-foot level.

*Dodgeville district.*—The production of lead concentrates increased in this district in 1911, but the output of sphalerite was less than in 1910. The Lucky Five Mining Co., on the Davis land, was the largest producer of zinc concentrates. The shaft at this mine is 100 feet deep and the concentrator has a capacity of 50 tons (10-hour shift). The Thomas land was leased by the Lucky Five, and some drilling was done. Harney, Bengeley & Davey shipped galena, sphalerite, and zinc carbonate concentrates from a mine on the Hughes land, and Wilcox Bros. produced some sphalerite and lead concentrates from the Sinson land.

The production of Evans Bros. and Carroll Guthrie was entirely of lead concentrates derived from ore mined through shallow shafts.

*Hazel Green district.*—Although there were only five producing properties in this district in 1911, the production of lead concentrates increased 306 tons and sphalerite concentrates increased 7,585 tons. The district ranked second in point of production in Wisconsin, displacing Platteville, which was in second place in 1910. The increased output of the Kennedy mine and the operation of the Cleveland mine accounted for the largely increased output.

The Mills mine of the Wisconsin Zinc Mining Co. continued to make a large production. Two shafts were operated at this mine, and the power for the mill, which has a capacity of 200 tons daily, was changed from steam to electricity. A roaster and separator having a daily capacity of 50 tons was erected in September, and roasted concentrates of 52.5 per cent zinc content were sold in October, 1911. The installation of another roaster and magnetic separator was commenced late in December.

The Kennedy mine of the Mineral Point Zinc Co. was the largest producer of sphalerite concentrates in Wisconsin in 1911 and also one of the largest producers of galena concentrates. Two concentrating plants of 125 tons each were operated until December 18, 1911, when one mill was totally destroyed by fire.

The Cleveland Mining Co., leasing on the Wetherbee land, made a large production of high-grade lead and zinc concentrates. The ore was hoisted by a 135-foot shaft and milled on a 150-ton electrically driven concentrating plant. The Federal Lead-Zinc Co., operating

on the Gray land, shipped a quantity of sphalerite concentrates. The power of the 50-ton mill was changed from steam to electricity.

The production of Williams & Son was galena concentrates obtained by shallow mining on the Crawford Mining Co.'s lands.

*Highland district.*—The production of zinc carbonate concentrates in the district in 1911 was only 364 tons less than in 1910, but the output of sphalerite declined from 1,116 tons to 81 tons and the galena from 630 tons to 206 tons. Over 70 per cent of the zinc carbonate concentrates were produced and shipped from the Highland and Franklin mines to the Mineral Point Zinc Co. Other shippers of zinc carbonate in 1911 were the Burrichter Mining Co., John Girman, Goldthorpe & Co., Imhoff, Egan & Kent, Madison Mining & Development Co. (Centerville mine), Kreul Mining Co., Minter Mining Co., J. Shaffra, and Whelan Bros. Lampe & Steppler obtained some rich ore by means of a 45-foot shaft and made the only large shipment of high-grade sphalerite concentrates. The Clark mine and 100-ton mill were not operated, but some concentrates produced in other years were sold in 1911. The Burrichter mine was worked by Clark & Muldernay, who sold some lead and carbonate of zinc.

The Madison Mining & Development Co. was one of the largest producers of zinc carbonate concentrates. The ore was hoisted by means of four 25-foot shafts on the Centerville Mining Co.'s land, and a large amount of development work was accomplished. The only 1911 shipments of the Minter Mining Co. were of ore mined and milled in 1910. The mill was utilized a part of the year in concentrating custom ore. Only development work was done in 1911 by Topp & Co., Frank Kroll, Fecht Mining Co., and Kennedy & Egan.

*Linden district.*—The production of sphalerite concentrates in the Linden district was 3,590 tons larger than it was in 1910, and the district ranked fourth in the State. The Optimo Mining Co. was the largest producer. The ore was mined from the 125-foot level by means of two shafts and was concentrated in a 75-ton mill. Ross Bros. sold the largest quantity of galena concentrates and the second largest quantity of sphalerite concentrates in 1911. The shaft at this mine is 100 feet deep and the concentrating plant has a capacity of 60 tons per 10-hour shift. The Hinkle Mining Co. was another large producer of both galena and sphalerite. One 80-foot shaft was used to hoist ore for the 50-ton (10-hour shift) mill. The only other large producer was the Glanville Mining Co., as the Gribble Harker Mining Co. sold only a small quantity of concentrates. The Rajah mine, which has a 110-foot shaft and a 50-ton mill, was purchased by the Mineral Point Zinc Co. late in the year. The Glanville Mining Co. leased the Smith mine and proceeded to sink a new shaft and install surface equipment.

*Livingston district.*—The 1911 output of this district was considerably smaller than in 1910. The Coker mine of the Mineral Point Zinc Co. was again the largest producer of lead and zinc. The 125-ton mill at this mine was totally destroyed by fire on August 6, 1911, but was rebuilt and again in operation on November 20. The Ellsworth mine, belonging to the Vinegar Hill Zinc Co., shipped no galena concentrates, but the output of sphalerite was very large. The concentrating plant at this mine has a capacity of 100 tons per 10-hour shift.

The Sunrise Mining Co. and White & Treager both sold a good tonnage of sphalerite concentrates. The Washburn mine, on the Wells land, was acquired by the Lost Mining Co., and a small quantity of concentrates was sold.

*Mifflin district.*—The output of this district in 1911 showed an increase of over 200 tons of galena concentrates and 1,000 tons of sphalerite concentrates, when compared with the year 1910. The Slack mine shipped most of the galena concentrates and a large tonnage of high-grade sphalerite concentrates, some of which was mined and milled before 1911. The shaft at this mine is 65 feet deep, and the concentrating plant has a capacity of 50 tons per shift. The Squirrel mine of the B. M. & B. Mining Co. made the largest output of zinc concentrates. The Peni Mining Co. not only milled a large tonnage of ore from their own mine but also did custom milling for the Shamrock, Big Tom, O. K., and Dodger mines. The Peacock mine, on the Jenkin land, operated a 25-ton mill and made a good yield of concentrates, particularly during the latter part of the year. The Grunow mine, on the Miller land, was operated by means of a 100-foot shaft, and the ore was milled at a 40-ton concentrating plant. The Dietzman Mining Co. worked the old O. K. mine through two shafts, one of which is 40 feet deep and the other 70 feet deep. Some production was made by the Clayton Mining Co., leasing on the Nolan & Cushman land, and by the Lucky Six Milling Co., formerly known as the Dodger mine.

*Mineral Point district.*—The only prominent producer in 1911 in this district was the Tripoli Mining Co., and in consequence the production showed a very large decrease from that of 1910. The Liverpool, Harris, Holman, and Merry Christmas mines made no output. The last-named mine was purchased by the Mineral Point Zinc Co. late in 1911.

*Montfort district.*—The shipments of sphalerite concentrates in 1911 were slightly larger than in 1910. The O. P. David Mining Co. was again the largest producer. The ore, which is of good grade, was hoisted by means of two shafts, each 127 feet deep, and concentrated at a 50-ton mill. The Relief mine was worked by the Madison Mining & Development Co. The ore is mined from an average depth of 50 feet through one shaft and the concentrating plant has a capacity of 100 tons per 10-hour shift.

*Platteville district.*—The mine production of sphalerite in this district in 1911 was 7,723 tons less than in 1910. A portion of this decrease was caused by the destruction by fire of the Mound City Mining & Milling Co.'s concentrator at the old Hodge mine. The mine had been actively worked prior to the fire and the production was large. The plant of the American Zinc Ore Separating Co., at Platteville, was also totally destroyed by fire in October, 1911. The Wisconsin Zinc Co. operated both the Empire and the Grant County mines. The Acme mine and mill of the same company were not operated, and the Mitchell Hollow plant was dismantled. The production of high-grade roasted sphalerite concentrates from the Empire and Grant County mines in 1911 was larger than from any other Wisconsin properties, although the mill at the Grant County was not operated until December. All of the ore treated was hoisted through Empire shaft No. 3, 130 feet deep, and Grant County shaft No. 2, 140 feet deep. The concentrating plant of the Empire mine is of

100 tons capacity (10-hour shift) and that of the Grant County mine 75 tons.

The largest production of green sphalerite concentrates in the district was made by the Klar Piquette Mining Co., which operated two 110-foot shafts and a 100-ton concentrator.

The Homestead mine on the Shepherd estate had a good output of high-grade roasted sphalerite concentrates. The St. Rose Mining Co.'s mill was operated during the first part of 1911, and drilling is reported to have revealed a new deposit of ore at some distance from the mill, which may necessitate a new shaft and the removal of the mill.

*Shullsburg district.*—The shipments of galena concentrates increased 63 tons in 1911, but the sphalerite shipments declined over 700 tons, when compared with the figures for 1910. The Rodham Mining Co., which is one of the largest producers of galena in Wisconsin, shipped most of the galena concentrates and a larger quantity of sphalerite concentrates than any other mine. Ore was hoisted through 2 shafts from the 75-foot level and concentrated at a mill having a capacity of 30 tons per 10-hour shift. A large portion of the zinc concentrates produced in 1911 was not sold. The Iron River Leasing Co. did considerable development work at the Brown-Croft mine, including the sinking of a new 90-foot shaft. The 50-ton mill was operated a part of the time and produced both lead and zinc concentrates. The Milwaukee-Shullsburg Mining Co. sunk a 122-foot shaft and erected a 50-ton mill, which was not in operation until the latter part of 1911.

Metcalf Bros.' mine produced both galena and sphalerite concentrates, but the 30-ton concentrator was not operated steadily. A new shaft was being sunk to the 80-foot level. The Maid of Erin and the Farrey Queen mines had each a small yield of galena concentrates, obtained during development work.

## BIBLIOGRAPHY.

### UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS ON LEAD AND ZINC IN THE CENTRAL STATES.[1]

ADAMS, G. I., Zinc and lead deposits of northern Arkansas: Bull. 213, 1903, pp. 187–196. 25 cents.

ADAMS, G. I., and others, Zinc and lead deposits of northern Arkansas: Prof. Paper 24, 1904, 118 pp.

BAIN, H. F., Lead and zinc deposits of Illinois: Bull. 225, 1904, pp. 202–207. 35 cents.

——— Lead and zinc resources of the United States: Bull. 260, 1905, pp. 251–273. 40 cents.

——— Zinc and lead ores in 1905: Mineral Resources U. S. for 1905, 1906, pp. 379–392. $1.

——— Zinc and lead deposits of northwestern Illinois: Bull. 246, 1905, 56 pp.

——— Zinc and lead deposits of the upper Mississippi Valley: Bull. 294, 1906, 155 pp.

BAIN, H. F., VAN HISE, C. R., and ADAMS, G. I., Preliminary report on the lead and zinc deposits of the Ozark region (Missouri-Arkansas): Twenty-second Ann. Rept., pt. 2, 1902, pp. 23–228. $2.25.

BUTLER, B. S., and SIEBENTHAL, C. E., Silver, copper, lead, and zinc in the Central States in 1909 (mine production): Mineral Resources U. S. for 1909, pt. 1, 1911, pp. 495–531. 60 cents.

[1] The publications for which a price is given can be purchased from the superintendent of documents, Washington, D. C.; the others can be obtained free on application to the Director of the United States Geological Survey. Some are out of print, but may be examined in libraries.

Butler, B. S., and Dunlop, J. P., Silver, copper, lead, and zinc in the Central States in 1910 (mine production): Mineral Resources U. S. for 1910, pt. 1, 1911, pp. 611–668.

Clerc, F. L., The mining and metallurgy of lead and zinc in the United States: Mineral Resources U. S. for 1882, 1883, pp. 358–386. 50 cents.

Ellis, E. E., Zinc and lead mines near Dodgeville, Wis.: Bull. 260, 1905, pp. 311–315. 40 cents.

Grant, U. S., Zinc and lead deposits of southwestern Wisconsin: Bull. 260, 1905, pp. 304–310. 40 cents.

Grant, U. S., and Burchard, E. F., Lancaster-Mineral Point folio (No. 145): Geol. Atlas U. S., 1907. 25 cents.

Lindgren, Waldemar, Resources of the United States in gold, silver, copper, lead, and zinc: Bull. 394, 1909, pp. 114–156.

Siebenthal, C. E., Mineral resources of northeastern Oklahoma: Bull. 340, 1908, pp. 187–228. 30 cents.

Smith, W. S. T., Lead and zinc deposits of the Joplin district, Missouri-Kansas: Bull. 213, 1903, pp. 197–204. 25 cents.

Smith, W. S. T., and Siebenthal, C. E., Joplin district folio (No. 148): Geol. Atlas U. S., 1907. 50 cents.

Ulrich, E. O., and Smith, W. S. T., Lead, zinc, and fluorspar deposits of western Kentucky: Bull. 213, 1903, pp. 205–213 (25 cents); Prof. Paper 36, 1905, 218 pp.

Winslow, Arthur, The disseminated lead ores of southeastern Missouri: Bull. 132, 1896, 31 pp. 5 cents.

# GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN STATES IN 1911.

(MINE PRODUCTION.)

By H. D. McCaskey.

## INTRODUCTION.

This report is a brief review of the gold, silver, copper, lead, and zinc mining industries of the Eastern or Appalachian States for the calendar year 1911. The area covered is for the greater part coincident with the broad belt of old metamorphic and associated igneous rocks extending southwestward from Canada to Alabama. The zinc-lead belt of southwest Virginia and eastern Tennessee, however, whose rocks are mainly Cambrian and Ordovician limestone and dolomite, lies to the west of this great metamorphic belt.

References were given in the report for 1908 to the most important papers on these mines in the Eastern States, and the geologic relations were briefly described, and this matter will not be repeated here. Copies of that report still remain available for distribution.

The copper mines of the Appalachian States have recently been described by Weed,[1] and his paper should be consulted by those interested in the mining of copper in the States mentioned in this report.

## PRODUCTION.

The total value of the mine output in the Eastern States of gold, silver, copper, lead, and zinc for the calendar year 1911 was $11,787,942. This represents the production of 96 mines, of which 57 were gold placer mines, many of them small. The total gold output was 7,709.52 fine ounces, valued at $159,370, and the silver production—recovered entirely in the refining of the gold and copper produced, as there are no true silver ores now worked in the Eastern States—was 108,105 fine ounces, valued at $57,296.

In 1911 the placers produced 1,447.28 fine ounces of gold and 138 fine ounces of silver; the siliceous or gold-quartz ores, 5,699.64 ounces of gold and 1,220 ounces of silver; and the copper ores, 562.60 ounces of gold and 106,747 ounces of silver. The small lead production of New York and Virginia was not a factor in the output of silver, and the zinc ores of the Eastern States do not contribute to the gold and silver supply.

The copper production, from copper and iron ores (and to a small degree from mine waters), amounted to 19,605,386 pounds, valued at

[1] Weed, W. H., Copper deposits of the Appalachian States: Bull. U. S. Geol. Survey No. 455, 1911.

$2,450,674, in 1911, an increase of 1,681,974 pounds in quantity and of $174,401 in value. The lead production, partly from lead ores, but mainly from lead-zinc ores, was 834,742 pounds, valued at $37,563, an increase of 635,892 pounds in quantity and of $28,813 in value. The zinc output, mainly from zinc ores, but in small part from lead-zinc ores, figured as spelter, was 159,351,558 pounds, valued at $9,083,039, an increase of 18,475,672 pounds in quantity and of $1,475,741 in value.

There were 42,970 short tons of siliceous gold ores treated in 1911, with an average recovered precious metal value of $2.76 per ton, against 60,410 tons in 1910, with an average value of $2.39 per ton. There were 801,842 short tons of copper ores treated, with an average recovered precious metal value of $0.085 per ton, against 774,040 tons with a gold and silver recovery of $0.076 in 1910. In addition to precious metals the copper ores yielded an average of 24.4 pounds of copper per ton treated in 1911, against an average of 23.2 pounds per ton in 1910. The output of zinc ore (including a nominal tonnage of old material) was 413,332 short tons in 1911, against an output of 411,381 short tons in 1910.

The gold production of the Eastern States decreased in value $26,152 in 1911, and the silver output increased by 16,510 fine ounces and $7,835 in value.

The following is a condensed tabulated statement of the production of the Eastern States in 1910 and 1911:

*Mine production of gold, silver, and associated metals in Eastern States in 1910 and 1911.*

| Years. | Gold. | | Silver. | | Copper. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | *Fine ounces.* | | *Fine ounces.* | | *Pounds.* | |
| 1910 | 8,974.63 | $185,522 | 91,595 | $49,461 | 17,923,412 | $2,276,273 |
| 1911 | 7,709.52 | 159,370 | 108,105 | 57,296 | 19,605,386 | 2,450,674 |
| Increase (+) or decrease (−) in 1911 | −1,265.11 | −26,152 | +16,510 | +7,835 | +1,681,974 | +174,401 |

| Years. | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | |
| 1910 | 198,850 | $8,750 | 140,875,886 | $7,607,298 | $10,127,304 |
| 1911 | 834,742 | 37,563 | 159,351,558 | 9,083,039 | 11,787,942 |
| Increase (+) or decrease (−) in 1911 | +635,892 | +28,813 | +18,475,672 | +1,475,741 | +1,660,638 |

The total tonnage reported as producing the five metals—gold, silver, copper, lead, and zinc—from deep mines in 1911 was 1,258,144 short tons, yielding a total metal value of $11,757,951. This gives an average recovered total metal value from deep mines in 1911 of $9.35 per ton of ore treated, against corresponding values of $8.06 for 1910 and of $8.91 for 1909.

## GOLD.

The production of gold in the Eastern States in 1911 was 7,709.52 fine ounces, valued at $159,370.[1] This shows a decrease in output of

[1] The value of gold is $20.671834625323 per fine ounce.

1,265.11 fine ounces in quantity and of $26,152 in value, as compared with the figures for 1910. The most notable increase was of over $8,000 from the copper ores of Tennessee. Increases of more than $2,000 each, mainly from siliceous ores, are also to be credited to North Carolina and Virginia. The most notable decreases were of nearly $18,000 in South Carolina and of more than $14,000 in Alabama. It seems probable that the gold production of South Carolina will increase in 1912. The output of Georgia remained about as in 1910. Of the gold output the placers yielded 1,447.28 ounces in 1911, against 1,524.54 ounces in 1910; the siliceous ores 5,699. 64 ounces in 1911, against 6,977.57 in 1910, and the copper ores 562.60 ounces in 1911 against 472.52 ounces in 1910.

## SILVER.

The production of silver in the Eastern States in 1911 was 108,105 fine ounces, valued at $57,296.[1] These figures show an increased output over that of 1910 of 16,510 fine ounces in quantity and of $7,835 in value. The only increased output for any State, however, was that from the copper ores of Tennessee, where it was valued at more than $12,000. Silver production in all other States decreased in 1911.

*Mine production of gold and silver in Eastern States in 1911, by States, in fine ounces.*

| States. | Gold. | | Silver. | | Increase (+) or decrease (−) in value compared with 1910. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Gold. | Silver. |
| Alabama | 915.06 | $18,916 | 171 | $91 | −$14,617 | − $54 |
| Georgia | 1,696.51 | 35,070 | 212 | 112 | − 532 | − 69 |
| Maryland, New Hampshire, and Pennsylvania | .43 | 9 | 87 | 46 | − 6,008 | − 238 |
| North Carolina | 3,399.89 | 70,282 | 943 | 500 | + 2,237 | − 4,388 |
| South Carolina | 987.24 | 20,408 | 11 | 6 | − 17,916 | − 19 |
| Tennessee | 562.17 | 11,621 | 106,660 | 56,530 | + 8,508 | +12,661 |
| Virginia | 148,22 | 3,064 | 21 | 11 | + 2,176 | − 58 |
| Total | 7,709.52 | 159,370 | 108,105 | 57,296 | | |
| Increase (+) or decrease (−) in 1911 | −1,265.11 | −26,152 | +16,510 | +7,835 | − 26,152 | + 7,835 |

*Source of gold and silver in Eastern States in 1911, by States, in fine ounces.*

| States. | Gold. | | | Silver. | | |
|---|---|---|---|---|---|---|
| | Placers. | Dry or siliceous ores. | Copper ores. | Placers. | Dry or siliceous ores. | Copper ores. |
| Alabama | | 915.06 | | | 171 | |
| Georgia | 1,148.32 | 548.19 | | 109 | 103 | |
| Maryland and Pennsylvania | | | .43 | | | 87 |
| North Carolina | 247.24 | 3,152.65 | | 22 | 921 | |
| South Carolina | 12.63 | 974.61 | | | 11 | |
| Tennessee | | | 562.17 | | | 106,660 |
| Virginia | 39.09 | 109.13 | | 7 | 14 | |
| Total | 1,447.28 | 5,699.64 | 562.60 | 138 | 1,220 | 106,747 |

[1] The average commercial price of silver per fine ounce in 1911 was 53 cents.

*Number of producing mines, ore production, and average value of gold and silver per ton in Eastern States in 1911, by States, in short tons.*

| State. | Number of mines. | | | Ore production from deep mines and average recovered value in gold and silver per short ton mined. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Placer. | Deep. | Total. | Total production. | Dry or siliceous ores. | | Copper ores. | | Lead ores.[a] | | Zinc ores.[a] | |
| | | | | | Quantity. | Average value. | Quantity. | Average value. | Quantity. | Average value. | Quantity. | Average value. |
| Alabama | .... | 2 | 2 | 6,360 | 6,360 | 2.99 | ..... | ..... | .... | .... | ..... | .... |
| Georgia | 24 | 7 | 31 | 3,737 | 3,737 | 3.05 | ..... | ..... | .... | .... | ..... | .... |
| Maryland and Pennsylvania | .... | 2 | 2 | 219,868 | ..... | ..... | 219,868 | 0.0002 | .... | .... | ..... | .... |
| New Jersey | .... | 1 | 1 | 374,064 | ..... | ..... | ..... | ..... | .... | .... | 374,064 | .... |
| North Carolina | 22 | 9 | 31 | 21,810 | 21,810 | 3.01 | ..... | ..... | .... | .... | ..... | .... |
| South Carolina | 6 | 3 | 9 | 9,302 | 9,302 | 2.17 | ..... | ..... | .... | .... | ..... | .... |
| Tennessee | .... | 5 | 5 | 604,538 | ..... | ..... | 581,974 | .117 | .... | .... | 22,564 | .... |
| Virginia and New York | 5 | 10 | 15 | 18,465 | 1,761 | 1.29 | ..... | ..... | 3 | .... | [b] 16,701 | .... |
| Total | 57 | 39 | 96 | 1,258,144 | 42,970 | 2.76 | 801,842 | .085 | 3 | .... | 413,329 | .... |

[a] No recovery of gold or silver from zinc or lead ores. [b] Includes lead-zinc ore.

## COPPER.

The copper production of the Eastern States in 1911 was 19,605,386 pounds, valued at $2,450,674,[1] an increase of 1,681,974 pounds in quantity and of $174,401 in value over the production of 1910. The most important production was, as usual, from the Ducktown district of Tennessee, the remainder of the output coming from Pennsylvania, Maryland, and Virginia in 1911.

## LEAD.

The production of lead from the Eastern States in 1911 was 834,742 pounds, valued at $37,563,[2] against 198,850 pounds, valued at $8,750, in 1910. The output was mainly from Virginia, but a nominal quantity came from New York.

## ZINC

The zinc production of the Eastern States in 1911, figured as spelter, was 159,351,558 pounds, valued at $9,083,039.[3] These figures show an increase in output of 18,475,672 pounds in quantity and of $1,475,741 in value for 1911. The bulk of the production was as usual from the mines at Franklin Furnace, N. J., but there is an increasing output coming from Tennessee; there was production from a new source in New York in 1911, and Virginia always contributes somewhat to the supply.

[1] The Survey figure for the average price of copper in 1911 is 12.5 cents per pound.
[2] The Survey figure for the average price of lead in 1911 is 4.5 cents per pound.
[3] The Survey figure for the average price of spelter in 1911 is 5.7 cents per pound.

*Mine production of copper, lead, and zinc in Eastern States in 1911, by States, in pounds.*

| States. | Copper. | | Lead. | | Zinc. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Maryland and Pennsylvania | 665,110 | $83,139 | | | | |
| New Jersey | | | | | 154,890,900 | $8,828,781 |
| North Carolina | | | | | | |
| Tennessee | 18,850,276 | 2,356,285 | | | 2,234,000 | 127,338 |
| Virginia and New York | 90,000 | 11,250 | 834,742 | $37,563 | 2,226,658 | 126,920 |
| Total | 19,605,386 | 2,450,674 | 834,742 | 37,563 | 159,351,558 | 9,083,039 |
| Increase in 1911 | +1,681,974 | +174,401 | +635,892 | +28,813 | +18,475,672 | +1,475,741 |

*Number of copper and zinc producing mines, ore tonnage, and average pounds of metal recovered per short ton of ore in Eastern States in 1911, by States.*

| States. | Number of mines. | | Copper ore. | | Lead ore. | | Zinc ore. | |
|---|---|---|---|---|---|---|---|---|
| | Copper. | Zinc. | Quantity. | Average per ton of ore. | Quantity. | Average per ton of ore. | Quantity. | Average per ton of ore. |
| Maryland and Pennsylvania | 2 | | 219,868 | 3.0 | | | | |
| New Jersey | | 1 | | | | | 374,064 | 414.1 |
| North Carolina | | | | | | | | |
| Tennessee | 2 | 3 | 581,974 | 32.4 | | | 22,564 | 99.0 |
| Virginia and New York | 1 | [a] 7 | (b) | | | | [c] 16,704 | (d) |
| Total | 5 | 11 | 801,842 | 24.4 | | | 413,332 | (d) |

[a] Includes lead and zinc mines.
[b] From mine water.
[c] Includes lead-zinc ores.
[d] Can not be given.

## REVIEW BY STATES.

### ALABAMA.

The mine production of gold in Alabama in 1911 was 915.06 fine ounces, valued at $18,916, and of silver, 171 fine ounces, valued at $91, against 1,622.16 fine ounces of gold, valued at $33,533, and 268 fine ounces of silver, valued at $145, in 1910. The value of the output decreased in 1911 therefore by $14,617 in gold and $54 in silver. The silver production is from recovery of this metal in refining the gold. No copper output and no placer production were reported from Alabama in 1911.

The mine production of Alabama in 1911 was from 6,360 short tons of siliceous ore with an average recovered value per ton in gold and silver of $2.99, against 9,763 tons averaging $3.41 in 1910 and 9,886 tons averaging $2.96 in 1909.

The output of 1911 was again mainly from the Hog Mountain mines in Tallapoosa County. The siliceous ores of this mine are in part oxidized and in part sulphides and they are treated in a 120-ton cyanide plant. No operations were reported at the Gold Ridge properties in Randolph County. At the Story prospect a small tonnage was treated in a 5-stamp amalgamation mill. The vein is in oxidized ore and is opened by an adit 150 feet long and a 75-foot shaft. Small trial shipments of gold ore only were made from the Holley prospect near Dadeville in Tallapoosa County.

## CONNECTICUT.

There has been no output of gold, silver, copper, lead, or zinc reported from Connecticut for many years. The occurrences of copper in this State have been recently briefly described by Weed.[1]

## GEORGIA.

The production of gold in Georgia in 1911 was 1,696.51 fine ounces, valued at $35,070, and that of silver was 212 fine ounces, valued at $112. In 1910 the gold output was 1,722.25 fine ounces, valued at $35,602, and the silver production was 335 fine ounces, valued at $181. The gold output therefore decreased $532 and the silver production $69 in value. No production of copper or lead was reported from Georgia in 1911.

The placer gold output was 1,148.32 fine ounces in 1911, against 880.96 ounces in 1910, and the remainder of the production, all from quartz ores in both years, was 548.19 fine ounces in 1911, against 841.29 ounces in 1910. The placer gold production has shown an increase and the deep-mine output a decrease during the last two years. The silver output from placer gold was 109 fine ounces in 1911 and that from the deep mines was 103 ounces.

There were 3,737 short tons of siliceous ores treated in 1911 with an average recovered value of $3.05 per ton in gold and silver, against 13,562 short tons with an average recovered value of $1.29 in 1910. Twenty-four placer mines and prospects and 7 deep mines were productive in 1911, against 23 placers and 8 deep mines in 1910.

The following table shows the production of gold and silver in Georgia by counties in 1911:

*Mine production of gold and silver in Georgia in 1911, by counties, in fine ounces.*

| Counties. | Gold. | | Silver. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Cherokee | 82.96 | $1,715 | 9 | $5 |
| Cobb | 4.74 | 98 | ..... | ..... |
| Dawson and Haralson | 89.73 | 1,855 | 27 | 14 |
| Fannin and Forsythe | 7.84 | 162 | ..... | ..... |
| Hall | 25.25 | 522 | 1 | 1 |
| Lumpkin | 554.43 | 11,461 | 50 | 26 |
| McDuffie | 311.49 | 6,439 | 39 | 21 |
| Oglethorpe | 6.82 | 141 | ..... | ..... |
| Rabun | 12.43 | 257 | 2 | 1 |
| White | 587.81 | 12,151 | 83 | 44 |
| Wilkes | 13.01 | 269 | 1 | ..... |
| Total | 1,696.51 | 35,070 | 212 | 112 |

*Cherokee County.*—The production of Cherokee County was 82.96 fine ounces of gold, valued at $1,715, and 9 fine ounces of silver, valued at $5, in 1911. This was an increase over the output for 1910, but was much below the production during the active operations of the well-known Franklin deep mine, which closed down in 1909.

[1] Weed, W. H., op. cit., pp. 35–37.

There was a small output from clean-up of the old mill and sluicing of placer gravel on this property. A small output and considerable prospecting were reported from the Worley mine, and a new mill was in process of erection there. No recovery of copper or output of pyrite from pyrite mines of Cherokee County was reported for 1912.

*Cobb County.*—A placer output of 4.74 fine ounces of gold, valued at $98, was reported from Cobb County in 1911.

*Dawson and Fannin counties.*—An increased output of placer gold was reported from the Blue Ridge Mountains in Dawson and Fannin counties in 1911.

*Forsythe County.*—A nominal output of placer gold was reported from the neighborhood of Cumming in Forsythe County in 1912. A lease was taken on the Big Creek placer, and the property and the Fannie deep mine were both prepared for operation in 1912. The gold-bearing veins on Sawnee Mountain are largely unprospected to date.

*Hall County.*—The production of Hall County, all from placers, was $522 in gold and 1 ounce of silver in 1911, against $2,229 in gold and 8 ounces of silver in 1910.

*Haralson County.*—A nominal output only was credited to the Royal mine for 1911.

*Lincoln County.*—The mines of Lincoln County were all reported idle in 1911. The Seminole mine, once a producer of copper and lead, was equipped with a concentrating mill and small roasting and blast furnaces.

*Lumpkin County.*—The production of Lumpkin County was 554.43 fine ounces of gold, valued at $11,461, and 50 ounces of silver, valued at $26, in 1911, against $10,919 in gold in 1910, and $20,944 in gold in 1909, with nominal quantities of silver in both years. This county includes the Dahlonega and Auraria districts, which have been notable producers in the past. Injunctions and other litigations are reported to have held back the development of the Dahlonega district in recent years. A considerably increased production seems possible from the properties there, many of which have been but partly developed and worked. There are annually small placer operations, some of them in old gravels that have been worked over several years. Placer work suffered generally, however, from a dry summer and lack of water in 1911. A nominal output was reported from the Gold Hill, McKee, and Sautee mines in Auraria, and from the Calhoun and Briar Patch placers south of Dahlonega. The New Findley deep mine and mill were operated for 10 months during the year, and the Standard, Singleton, and Lockart mines were small producers in 1911. The Bunker Hill Gold-Mining & Dredging Co. developed considerable placer and bench gravel by shafts and drill holes on Chestatee River, leased the Bucyrus bucket dredge of the Seawell Gold Dredging Co., and made an output by working through tailings and barren ground to reach their own holdings.

*McDuffie County.*—The output reported from McDuffie County was 311.49 fine ounces of gold, valued at $6,439, and 39 ounces of silver, valued at $21, against a production valued at $7,390 in 1910. The producers were mainly the mines of the Hamilton-Parker-Columbia group, near Thomson. The Juanita and Tatham mines were both idle. The Tatham is developed by a 120-foot inclined shaft on the

vein, now caved to water level (which is 40 feet from the surface), and and is equipped with a 10-stamp amalgamation mill and Wilfley concentrator. The ore is gold quartz carrying pyrite, chalcopyrite, galena, and a little zinc blende. The ore is oxidized to water level, below which gold is found both free and in the sulphides.

*Oglethorpe and Rabun counties.*—A nominal output of gold was reported from Oglethorpe and Rabun counties in 1911.

*Union County.*—There was no production from Union County in 1911, but the Coosa Creek mines were prospected and developed and preparations were made for active operation in 1912.

*White County.*—The production of White County was 587.81 fine ounces of gold, valued at $12,151, and 83 ounces of silver, valued at $44, in 1911, the largest county output of the State. The output of gold was valued at $5,366 in 1910 and at $3,501 in 1909—a steady increase in the last two years. The production is mainly from the well-known Loud placers, from which handsome specimens of nuggets are often obtained. There was considerable activity in other placers also. At the Wolff mine the ground was tested by ground sluicing and the property was being equipped with 12-inch pipe line and reservoir for hydraulicking. The Unicay placer was also tested, and 2 miles of ditch and flumes were built to bring water on the ground. The Parks deep mine was being equipped with a stamp mill.

## MAINE.

There was no output of gold, silver, copper, lead, or zinc ore from any mine in Maine in 1911.

The copper deposits of Maine have been briefly referred to by Weed [1] and Emmons.[2]

## MARYLAND.

A small production of concentrates, carrying copper and silver, was shipped from the New London mine, near Monrovia, in Frederick County, Md., in 1912. This property is now reported to be developed by an inclined shaft 300 feet deep and about 900 feet of underground workings. The shaft was recently sunk 100 feet, and 200 feet of drifting has been done. The mine is equipped with a 100-ton concentrating mill, including Hardinge pebble mill, trommel, and slime tables.

## MASSACHUSETTS.

No production of copper, lead, zinc, gold, or silver was reported from mines in Massachusetts in 1911. There has been of recent years some small recovery of copper as a by-product from pyrite ores of this State, but none was reported for 1911. Near the old Chipman lead mine, at Newburyport, Essex County, a new prospect was developed in 1911, but without result to date of report; another prospect near by developed a small quantity of ore containing copper, lead, zinc, silver, and gold in 1911.

[1] Weed, W. H., op. cit., p. 16.
[2] Emmons, W. H., Some ore deposits in Maine and the Milan mine, New Hampshire; Bull. U. S. Geol. Survey No. 432, 1910.

## NEW HAMPSHIRE.

There was no production reported of copper, lead, zinc, gold, or silver from New Hampshire in 1911. The Milan mine, recently described by Emmons,[1] was idle.

## NEW JERSEY.

In New Jersey the well-known zinc mines at Franklin Furnace, in Sussex County, continued their important output of zinc throughout 1911, sending 306,168 short tons of ore to the concentrating mills (producing 252,166 short tons of concentrates), and 67,896 tons of crude ores to smelters. Figured as metallic zinc, the total recoverable output was 154,890,900 pounds of spelter, an increase of 17,535,681 pounds over the output of 1910. The ore is crushed, screened, and concentrates are produced by magnetic separation and by jigging. The tailings are discarded. The concentrates are classed as franklinite, willemite, and "half-and-half," in descending quantity of output.

The Pahaquarry copper mine, in Warren County, at Dimmicks Ferry, on Delaware River, was operated for three months and the 200-ton concentrating mill for two months in 1911, but no concentrates were shipped. The ore mineral, chalcocite, is reported to break too fine for profitable extraction by the process used, and losses were considerable. Experiments were being made to improve the saving.

## NEW YORK.

No commercial production of gold, silver, or copper was reported from New York in 1911, though small quantities of lead and zinc were recovered in development work in St. Lawrence County.

Considerable interest has been shown at a number of points in Lewis County in the attempt to save gold from the Adirondack sands. A number of processes have been experimented with, according to reports, but, so far as could be ascertained by the Survey, with negative results.

In St. Lawrence County, where well-known pyrite mines have been in successful operation for many years, some development of lead and zinc deposits is noted for 1911. Near Gouverneur a vein of lead ore was prospected, and a small shipment of sorted ore resulted in recovery of lead by the smelters and of a nominal quantity of gold and silver. Near Edwards the Northern Ore Co. developed a deposit of blende and pyrite and shipped to zinc smelters a small tonnage of crude ore (averaging 36.5 per cent of zinc), extracted in development work, reserving a much larger tonnage on the stock piles for treatment in the mill at the mine and blocking out ore for further supplies. An incline shaft at an angle of 42° was sunk 180 feet on the vein in 1911, and drifts in ore were run 300 feet with upraises at 100-foot intervals. A 50-ton mill, in process of erection, will separate the zinc blende from the gangue and pyrite, and concentrate the latter, thus rendering both blende and pyrite marketable. The plant is equipped with electric and steam power in both mine and mill. Con-

[1] Emmons, Wm. H., op. cit., pp. 50–60.

siderable prospecting and development of additional deposits are planned by the company, and the outcome of the new zinc industry in this district will be noted with interest.

## NORTH CAROLINA.

The mine production of gold, silver, and copper in North Carolina in 1910 and 1911 is shown in the following table:

*Mine production of gold, silver, and copper in North Carolina in 1910 and 1911.*

| Year. | Gold. | | Silver. | | Copper. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ozs.* | | *Fine ozs.* | | *Pounds.* | | |
| 1910 | 3,291.68 | $68,045 | 9,053 | $4,888 | 140,514 | $17,845 | $90,778 |
| 1911 | 3,399.89 | 70,282 | 943 | 500 | ..... | ..... | 70,782 |
| Increase (+) or decrease (−) in 1911 | +108.21 | +2,237 | −8,110 | −4,388 | −140,514 | −17,845 | −19,996 |

The output of gold in North Carolina in 1911 was 3,399.89 fine ounces, valued at $70,282, an increase over the production of 1910 of 108.21 ounces in quantity and of $2,237 in value, and over the production of 1909 of $30,052 in value. The yield of silver is merely the recovery in refining the gold and copper produced, and as there was no copper output reported from the mines in 1911, the silver production decreased from 9,053 to 943 ounces, a decline of 8,110 ounces in quantity and of $4,388 in value. The copper production in 1910 was 140,514 pounds, valued at $17,845, a large decrease from that of 1909; and, as stated, there was no copper output reported for 1911. North Carolina produced nearly half the entire output of gold in the Eastern States in 1911 and easily retains first rank in output of this metal east of the Mississippi.

The following table shows the reported mine output of gold and silver in North Carolina in 1911 by counties:

*Mine production of gold and silver in North Carolina in 1911, by counties.*

| County. | Gold. | | Silver. | | Total value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ozs.* | | *Fine ozs.* | | |
| Burke | 34.54 | $714 | 5 | $3 | $717 |
| Cabarrus | 75.80 | 1,567 | 3 | 2 | 1,569 |
| Catawba | 345.79 | 7,148 | 124 | 66 | 7,214 |
| Cherokee and Polk | 28.64 | 592 | 9 | 4 | 596 |
| Franklin and Mecklenburg | 78.27 | 1,618 | 5 | 3 | 1,621 |
| McDowell | 15.04 | 311 | 2 | 1 | 312 |
| Montgomery | 2,698.36 | 55,780 | 762 | 404 | 56,184 |
| Moore | 10.40 | 215 | ..... | ..... | 215 |
| Randolph | 10.26 | 212 | 4 | 2 | 214 |
| Rowan | 62.93 | 1,301 | 8 | 4 | 1,305 |
| Rutherford and Yadkin | 5.13 | 106 | ..... | ..... | 106 |
| Union | 34.73 | 718 | 21 | 11 | 729 |
| Total | 3,399.89 | 70,282 | 943 | 500 | 70,782 |

*Burke County.*—The production of Burke County in 1911 was $714 in gold, against $2,891 in 1910 and $4,535 in 1909, with a nominal output of recovered silver each year. The production of 1911 was mainly from small placer operations near Bridgewater.

*Cabarrus County.*—The production of Cabarrus County was $1,567 in gold in 1911, against $913 in 1910. Small placer operations at the Gorman mine, the Saunders, the old dump of the Phoenix, old concentrates of the McMakin, and at other localities, resulted in the bulk of the output. At the Reed mine, near Meadow Creek, the old shaft was retimbered and sinking was begun.

*Catawba County.*—The gold production of Catawba County was $7,148 in 1911. The Shuford mine was again the main producer.

*Cherokee County.*—During three months of 1911 a small amount of sluicing of stream and bench gravels on the middle branch of Tathams Creek, near Andrews, in Cherokee County, resulted in a nominal output of gold nuggets. Operations were suspended shortly after they were begun owing to the death of the owner.

*Davidson County.*—Resumption of operations on a small scale at the old Silver Hill mine in the Cid district of Davidson County has been recently reported, but no production is recorded from this county for 1911.

*Franklin County.*—In Franklin County there was but a nominal output of gold in 1911. At the Portis mine near Wood, on Fishing Creek, preparations were made to work 1,000 cubic yards daily from open cuts, disintegrating the surface material by mechanical pulverizers and passing it over riffles containing quicksilver.

*McDowell County.*—A nominal output of placer gold was derived from small operations near Dysartville and Vein Mountain, in McDowell County, in 1911.

*Mecklenburg County.*—There was little activity in gold mining in Mecklenburg County in 1911. The main producer was the dredge of the Catawba Gold Dredging Co. on Catawba River, which produced small lots of gold and a marketable product in the tailings, which are sold for making concrete.

*Montgomery County.*—The production of Montgomery County was $55,780 in gold and 762 fine ounces of silver, valued at $404, in 1911, an increase over the output of 1910. The Iola mine, near Candor, was the most important gold producer from siliceous gold ores in the South in 1911, and has been the largest producer in the State for several years. The old milling plant was destroyed by fire in December, 1910, and a new mill using the "all sliming" process was built in 1911 and put into operation in August. This is a 45-ton cyanide plant with five 1,750-pound stamps, crushing through ¼-inch mesh, followed by tube-mill grinding to 200 mesh. The slimes pass through Dorr classifiers and thickeners, continuous Pachuca tanks, and Kelley filters, and the solutions through zinc precipitation boxes. The mine is opened by a 450-foot incline shaft and a 650-foot one-turn vertical shaft with 300 feet vertical and 350 feet on the incline. The old Coggins mine, another producer, was unwatered and repaired in 1910 and a 40-ton Lane slow-speed Chilian mill with amalgamation and concentration equipment was completed in 1911. The ore is siliceous, carrying mainly free-milling gold. The mine is opened by a shaft 226 feet on the incline and by 660 feet of levels and crosscuts. The Martha Washington prospect is developed by a 50-foot incline shaft

and is being further developed preparatory to the erection of a mill. The Uwarra (old Montgomery) mine was reopened in 1911 and was actively developed. It is opened by a 225-foot vertical shaft and 1,000 feet of drifts. A 50-ton fine-grinding and cyaniding plant was in prospect for 1912.

*Moore County.*—A nominal output only of gold from small prospects near the old Cagle mine was reported from Moore County in 1911.

*Nash County.*—Considerable prospecting in a small way is reported to have located a number of outcrops of gold and copper ore within a few miles of Nashville, in Nash County, but no production was recorded for 1911.

*Polk County.*—The Double Branch mine, in the soutnern part of Polk County, was a producer in 1911. The property is opened by several shafts and equipped with a stamp-milling, amalgamating, and concentrating plant.

*Randolph County.*—From the Ashboro property in Randolph County there was a nominal placer output, but attention was given mainly to prospecting quartz mines. The Redding mine, with prospecting equipment, was being developed and made a nominal output. A small amount of prospecting and nominal outputs were reported from other properties.

*Rowan County.*—The year 1911 was marked by little activity in mining in Rowan County. A small output was obtained from Third Creek and from washing over old tailings and concentrates. The well-known Gold Hill mines were generally inactive during the year.

*Rutherford and Yadkin counties.*—A nominal output of gold was reported from Rutherford and Yadkin counties in 1911.

*Union County.*—In Union County there was a small output of gold in 1911 from the Bonnie Doon and other mines near Indian Trail, but the year was generally quiet, and the Bonnie Doon was operated but a few months under lease before closing down. Some development work was done on the Winona-Davis-Price properties near Matthews.

## PENNSYLVANIA.

*Adams County.*—There has been considerable activity in prospecting and developing copper deposits near Charmian, in Adams County, in 1910 and 1911. These have been described by Stose,[1] and Weed[2] has given a general account of copper occurrences in Pennsylvania. At the Bingham mine development is by open cut, exposing a body of ore carrying native copper. It is planned to break this down and ship to smelters. The Reed Hill prospect was not operated in 1911. At the Virgin mine operations consisted in slope sinking and crosscutting. At the Eagle mine a 175-ton furnace has been erected, and considerable ore was broken in an open cut for smelting. No production of copper was reported from this county in 1911, but an output, from trial work at least, is expected for 1912.

*Lebanon County.*—An important output of copper as a by-product from magnetic separation of the iron ores of the Cornwall mine, in Lebanon County, was again reported for 1911. The mine is worked by open cut, and the plant includes a 1,000-ton concentrator, in

[1] Stose, G. W., The copper deposits of South Mountain in southern Pennsylvania: Bull. U. S. Geol. Survey No. 430, 1910, p. 122.
[2] Weed, W. H., op. cit., pp. 57–62.

which the iron oxides are magnetically separated and the tailings are concentrated for the copper sulphides, which are briquetted according to the Gröndal process and sold to copper smelters. The deposits are described by Spencer.[1]

## SOUTH CAROLINA.

The mine production of gold in South Carolina in 1911 was 987.24 fine ounces, valued at $20,408, and that of silver was 11 fine ounces, valued at $6. This was a decrease from the output of 1910 of $17,916 in gold and $19 in silver. The yield of gold and silver in 1911 was reported from 6 placers and 3 deep mines, against 10 placers and 2 deep mines in 1910. The total reported placer output of gold was only 12.63 fine ounces in 1911, while the deep-mine output, from 9,302 short tons of siliceous gold ore, was 974.61 fine ounces. The total recovered precious metal value per ton of siliceous ores treated in South Carolina was $2.17 in 1911, $1.50 in 1910 and $3.06 in 1909.

*Abbeville and other counties.*—There was a nominal output of gold from placers in Abbeville, Cherokee, Chester, Chesterfield, and Greenville counties in 1911. At the Flint Hill mine, near Gaffney, in Cherokee County, a 40-ton plant was in prospect for 1912.

*Lancaster County.*—The well-known Haile mine, near Kershaw, in Lancaster County, was operated for about 4 months in 1911. Under new management the plant is being refitted and changes are planned in mining methods. The deposit is developed by shaft and open cuts, and the plant includes a 60-stamp concentration and chlorination mill.

*Spartanburg and other counties.*—In Spartanburg County there was a nominal output of placer gold from Becks Branch in 1911, and there was a small placer production from Union and York counties. From the Schoolhouse-Parker group, in York County, small shipments of ore were sent to Ducktown smelters.

## TENNESSEE.

The mine production of gold, silver, copper, and zinc in Tennessee in 1911 is shown in the following table:

*Mine production of gold, silver, copper, and zinc in Tennessee in 1910 and 1911.*

| Year. | Gold. | | Silver. | | Copper. | | Zinc. | | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Fine ounces.* | | *Fine ounces.* | | *Pounds.* | | *Pounds.* | | |
| 1910 | 150.59 | $3,113 | 81,239 | $43,869 | 16,837,727 | $2,138,391 | 1,932,555 | $104,358 | $2,289,731 |
| 1911 | 562.17 | 11,621 | 106,660 | 56,530 | 18,850,276 | 2,356,285 | 2,234,000 | 127,338 | 2,551,774 |
| Increase in 1911 | 411.58 | 8,508 | 25,421 | 12,661 | 2,012,549 | 217,894 | 301,445 | 22,980 | 262,043 |

The mine output of gold, silver, copper, and zinc in Tennessee in 1911 was valued at $2,551,774, an increase of $262,043 over the value

[1] Spencer, A. C., Magnetite deposits of the Cornwall type in Pennsylvania: Bull. U. S. Geol. Survey No. 359, 1908.

of 1910. The gold production was 562.17 fine ounces, valued at $11,621; the silver production, 106,660 fine ounces, valued at $56,530; the copper output, 18,850,276 pounds, valued at $2,356,285; and the zinc production, figured as spelter, 2,234,000 pounds, valued at $127,338. Compared with the output of 1910 the gold production increased in value $8,508; the silver, $12,661; the copper, $217,894; and the zinc, $22,980.

There were no gold, silver, or lead mines productive in Tennessee in 1911, and the entire output of gold, silver, and copper was from 581,974 short tons of copper ore, with an average total recovered precious metal value of $0.117 per ton, and a copper content of 32.4 pounds per ton treated.

The zinc output was entirely from 22,564 tons of zinc ores. An extensive and systematic campaign of prospecting the zinc deposits, especially of Jefferson and Knox counties, was carried on by drilling in 1911, with reported generally favorable results, and the outlook is for an increasing output from this field.

*Jefferson County.*—An increased output of zinc ore was reported from Jefferson County in 1911. The Loy or Newmarket mine, southeast of Newmarket, was actively developed by shallow vertical shafts from 75 to 100 feet deep and by open cuts, and was an important producer of zinc carbonate ore. The ore was concentrated in a mill recently enlarged to treat 150 tons per day, including log washers, jigs, and tables; and the concentrates were shipped. The Jolly mine, farther southeast, producing zinc blende, was prospected in 1911, and made a small output, according to reports. The Miller and Nance properties, to the west of Newmarket, and the Gillespie on the east, were also prospected during 1911.

*Knox County.*—The Holston zinc mine, west of Mascot, in Knox County, was under development in 1911, and a small quantity of blende concentrates were shipped, resulting from experimental milling of crude ore mined. The property is opened by vertical shafts 180 and 380 feet deep and 650 feet apart and further development will be by levels. A modified Joplin mill is planned to treat the ore. The Roseberry zinc mine, also west of Mascot, and containing zinc blende ores has been prospected by churn drills, but did not reach the producing stage in 1911. Extensive prospecting was also done on other lands near Mascot in 1911 and increased preparatory work by drilling was in prospect for 1912.

*Monroe County.*—No output of placer gold was reported from Coker Creek and adjoining placer fields in Monroe County in 1911. This gold-gravel region was the subject of an interesting preliminary study by Ashley [1] during the year.

*Polk County.*—The well-known copper deposits of Ducktown, Polk County, have been recently studied in the field and described by Emmons and Laney.[2]

This district produced all the copper, silver, and gold for Tennessee in 1911. The Burra-Burra, London, Polk County, and Eureka mines of the Tennessee Copper Co., opened by shafts 797, 588, 485, and 165 feet deep, respectively, in 1911, were developed during the year by

[1] Ashley, G. H., The gold field of Coker Creek; the resources of Tennessee: Geol. Survey Tennessee, vol. 1, No. 3, Nashville, September, 1911, pp. 78–107.

[2] Emmons, W. H., and Laney, F. B., Preliminary report on the mineral deposits of Ducktown, Tenn.: Bull. U. S. Geol. Survey No. 470, 1911, pp. 151–172.

2,839 feet of drifts, 163 feet of station cutting, and 770 feet of raises and winzes. The ore treated is copper sulphide. About one-quarter of the Bessemer pig copper produced in the plant is shipped to Europe without refining, and therefore produces no domestic silver nor gold, and the remainder is refined in the United States. The Mary, the East Tennessee, and the Isabella mines, of the Ducktown Sulphur, Copper & Iron Co., are opened by vertical shafts 700 and 900 feet deep. The plant includes two 350-ton smelters and the process is pyritic smelting. In addition to the metals produced in the Ducktown district an important by-product is now the sulphuric acid saved from the roasting of the sulphide ores.[1]

*Sullivan County.*—A small amount of development work only was reported in 1911 from the east Tennessee lead-zinc mine, near Falls Branch, in Sullivan County.

## VERMONT.

No production nor operations were reported at the copper mines of Orange County, Vt., in 1911.

## VIRGINIA.

The mine output of gold, silver, copper, lead, and zinc in Virginia in 1911 is shown in the following table:

*Mine production of gold, silver, copper, lead, and zinc in Virginia, in 1910 and 1911.*

| Year. | Gold. | | Silver. | | Copper. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | *Fine ozs.* | | *Fine ozs.* | | *Pounds.* | |
| 1910 | 42.96 | $888 | 128 | $69 | 5,402 | $686 |
| 1911 | 148.22 | 3,064 | 21 | 11 | 90,000 | 11,250 |
| Increase (+) or decrease (−) in 1911 | +105.26 | +2,176 | −107 | −58 | +84,598 | +10,564 |

| Year. | Lead. | | Zinc. | | Total value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | |
| 1910 | 198,850 | $8,750 | 1,588,112 | $85,758 | $96,151 |
| 1911 | [a] 834,742 | [a] 37,563 | [a] 2,226,658 | [a] 126,920 | [b] 169,394 |
| Increase (+) or decrease (−) in 1911 | | | | | +73,243 |

[a] Includes small production of lead and zinc of New York.
[b] Total value given is that of the gold, silver, copper, lead, and zinc produced in Virginia in 1911.

The value of the production of gold, silver, copper, lead, and zinc in Virginia in 1911 was $169,394, an increase of $73,243 as compared with the corresponding value for 1910.

The production of gold in 1911 was $3,064, an increase of $2,176, but the output of silver fell to 21 fine ounces, valued at $11, a decrease of 107 ounces in quantity and of $58 in value. Figures for the

[1] Laney, F. B., Manufacture of sulphuric acid from smelter fumes at Ducktown, Tenn.: Mineral Resources U. S. for 1911, U. S. Geol. Survey, 1912.

output of lead and zinc have been combined with those of another State to conceal individual production. The production of gold included 39.09 fine ounces from placers and 109.13 ounces from siliceous ores, and the output of silver was 7 ounces from placers and 14 ounces from siliceous ores. The quantity of gold-quartz ores treated in Virginia in 1911 was 1,761 short tons, with an average recovered precious metal value of $1.29 per ton, against 239 tons of gold-quartz ore in 1910, with a recovered value of $2.78 per ton.

*Halifax County.*—No output of copper, silver, or gold was reported from the Virgilina district, in Halifax County, in 1911. A small amount of development and exploration work and small trial shipments to ascertain the value of ores were reported from the district. There was promise of increased development at the Pool gold prospect for 1912.

*Louisa County.*—In Louisa County are important mines that have been producing pyrite in large quantities for many years. From the mine waters cement copper has been from time to time a valuable by-product also. At the Arminius mine the copper content of the waters has of late become too low to justify treatment, but the Sulphur mines made a considerable output of cement copper in 1911. In addition to pyrite the ores of the Arminius include zinc, lead, and copper sulphides, and some shipments of these were reported for 1911. A new incline shaft is being sunk at this mine 800 feet north of the older shaft which is now 1,100 feet down on an incline of 60° SE.

*Albemarle and Floyd counties.*—A nominal output of gold was reported from Albemarle and Floyd counties in 1911.

*Fluvanna County.*—The Scotia mine, in Fluvanna County, was prospected for six months in 1911 and a small tonnage was extracted.

*Goochland County.*—In Goochland County an output of placer gold was reported in 1911 from small operations near Lantana. The Waller deep gold prospect has been developed by an 84-foot shaft, and oxide ores are reported in the entire depth. Development work only was reported from the Martha Payne prospect. The Gilmer mine of the Young America Gold Mining Co. produced gold and silver from crude ore milled and amalgamated and from a small lot of concentrates shipped. The shaft is 80 feet down, of which 54 feet were sunk in 1911. The plant includes a Lane slow-speed Chilian mill with Traylor concentrator and Pierce amalgamator. A cyanide plant is in prospect for treating the tailings which are reported to carry $2 per ton in gold.

*Prince William County.*—No production of copper was reported from the Cabin Branch pyrite mine, near Dumfries, in Prince William County, in 1911.

*Spottsylvania County.*—In Spottsylvania County, near the Louisa County line, and in continuation of the Louisa mineral belt, are the Grindstone and Holladay prospects. Several shafts have been sunk to explore the gold and the zinc-lead-silver veins found. From the Holladay property a trial shipment of lead-zinc ore was made in 1911.

*Wythe County.*—The Austinville and Bertha mines in Wythe County continued production of lead and zinc in 1911. From the Austinville mine lead and zinc concentrates and material from old smelter clean-ups was shipped, and zinc was recovered from old tailings of the Bertha mine.

# QUICKSILVER.

By H. D. McCaskey.

## INTRODUCTION.

Preliminary figures on the production of quicksilver in the United States in 1911 were published by the United States Geological Survey on January 19, 1912. In these figures an output for 1911 of 21,821 flasks of 75 pounds each was reported for the United States, of which 19,131 flasks were assigned to California and 2,690 flasks to Nevada and Texas combined. Final and revised figures give a total of 21,256 flasks as the output of the United States in 1911, of which 18,860 flasks were produced in California and 2,396 flasks in Nevada and Texas combined.

## CONDITION OF THE INDUSTRY.

The material decrease in domestic stock of quicksilver available for consumption indicated in the Survey report for 1910 became marked in 1911. This resulted in the heaviest importation and the the lightest exportation in many years, gave an excellent market for new production, and assisted in the maintenance of good prices. The tendency of better markets and prices in turn played some part in increasing the output and the production in 1911 was the largest since 1907, although over 5,000 flasks below the average annual output for the decade ending with 1911, as appears from the table on a subsequent page.

Consumption is mainly in the manufacture of fulminate for explosive caps, of vermilion, of drugs, of electric lighting apparatus, of scientific apparatus, and in metallurgy in the recovery of gold and silver, principally of gold by amalgamation. There is little prospect for materially increased output from the old producing mines, and the eventual working out of well-known deposits will probably barely be offset by the development of new ore bodies now known. The low tenor of the bulk of the ores now worked, the increasing cost of production, the present low tariff, the remote locations of the Nevada and Texas producers and their consequent difficulties of supply, cause the present outlook for increased quicksilver production not to be particularly bright—except possibly for the largest mines. These mines are probably mainly to be depended upon for the bulk of the domestic output, but no great increase in production as a whole is expected. This fact, and the probable continuance of the annual domestic demand for at least 20,000 flasks of quicksilver should continue a good market at fairly good prices. High prices will bring in

foreign supplies at the present tariff rate, which is 7 cents per pound, or $5.25 per flask of 75 pounds, and will react to continue prices at probably under $50 per flask. The foreign market is open to competition with the great European supplies, mainly from Spain and controlled in London. Old producers, therefore, with established plants and organizations, would apparently need to concern themselves mainly with development of sufficient ore of workable grade to keep their plants in operation; new producers can apparently depend upon fair market and prices, but, as in other mining, must assure themselves of sufficient ore of sufficient value to offset the cost of erecting plants, of establishing communications, and of organization, before they can secure profit upon their investments.

## PRODUCTION.

### NUMBER OF MINES, METAL OUTPUT, AND VALUE.

In 1911 there were altogether 25 mines producing quicksilver in the United States, against 19 in 1910. In both years there were several mines and prospects additional that produced ore but no metal and on the other hand several old mines that produced metal but no ore. Twenty-two of the 25 producing mines in 1911 were in California, and 3 in Nevada and Texas. As in 1910, there was no output of quicksilver from Arizona, Oregon, Utah, or Washington.

According to confidential returns to the Survey from every producing district, the output of quicksilver in the United States in 1911, as already stated, was 21,256 flasks of 75 pounds each. At the average domestic price at San Francisco for the year of $46.01 per flask this output was valued at $977,989. As compared with the production of 1910, which was 20,601 flasks, valued at $958,153, the output for 1911 showed an increase of 655 flasks in quantity and of $19,836 in value, against a decrease in 1910 of 474 flasks in quantity and an increase of $294 in value. The production of California increased from 17,211 flasks, valued at $800,484, in 1910 to 18,860 flasks, valued at $867,749, in 1911; but the output of Nevada and Texas combined decreased from 3,390 flasks, valued at $157,669, in 1910 to 2,396 flasks, valued at $110,240, in 1911. There was no production from any other State in 1911. Although a larger production may be looked for from Nevada, the total domestic production for 1912 will probably not exceed 22,000 flasks.

The following table shows the production for 1910 and 1911:

*Production of quicksilver in the United States in 1910 and 1911, by States, in flasks of 75 pounds.*

| State. | 1910 | | 1911 | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| California | 17,211 | $800,484 | 18,860 | $867,749 |
| Nevada and Texas | 3,390 | 157,669 | 2,396 | 110,240 |
| Total | 20,601 | 958,153 | 21,256 | 977,989 |

There is, in addition to production from ore and furnace material given above, an annual output of secondary quicksilver from clean-ups of old gold and silver amalgamation mills as on the Comstock in Nevada, and in Colorado and elsewhere. This source of supply tends to reduce somewhat the market for new metal but probably only to a small degree. Figures for output of secondary quicksilver are incomplete.

## PRODUCTION OF QUICKSILVER FOR THE DECADE ENDING 1911.

The production of quicksilver in the United States for the decade ending with 1911 has been as follows:

*Production of quicksilver in the United States from 1902 to 1911, inclusive, in flasks.*[a]

| Year. | Arizona. | California. | Nevada. | Oregon. | Texas. | Utah. | Total. |
|---|---|---|---|---|---|---|---|
| 1902 | ..... | 28,972 | ..... | ..... | 5,319 | ..... | 34,291 |
| 1903 | ..... | 30,526 | 65 | ..... | 5,029 | 14 | 35,634 |
| 1904 | ..... | 29,217 | 17 | ..... | 5,336 | 745 | 35,315 |
| 1905 | ..... | 24,635 | ..... | 43 | 4,723 | 1,133 | 30,534 |
| 1906 | ..... | 20,310 | ..... | 3 | 4,761 | 1,009 | 26,083 |
| 1907 | ..... | 17,431 | ..... | ..... | 3,686 | 437 | 21,554 |
| 1908 | (b) | 16,984 | ..... | [b]386 | 2,382 | ..... | 19,752 |
| 1909 | ..... | 16,078 | [c]809 | (c) | 4,188 | ..... | 21,075 |
| 1910 | ..... | 17,211 | 70 | ..... | 3,320 | ..... | 20,601 |
| 1911 | ..... | 18,860 | (d) | ..... | [d]2,396 | ..... | 21,256 |
| Total | ..... | 220,224 | 961 | 432 | 41,140 | 3,338 | 266,095 |

[a] 76½ pounds net for 1902, 1903, and 5 months of 1904; 75 pounds since June 1, 1904.
[b] Arizona and Oregon combined for 1908.
[c] Nevada and Oregon combined for 1909.
[d] Nevada and Texas combined for 1911.

In this table the figures for Utah are in part corrected by latest information from figures first furnished the Survey and published in previous Mineral Resources reports.

The average annual output for the decade was 26,609.5 flasks, and for California 22,022 flasks. The outputs for the last six years for the United States and for California have therefore been below these averages. For the decade it is to be noted that California has supplied 220,224 flasks of the total of 266,095 flasks for the United States, or 82.8 per cent of the output. Until Texas began production in 1899 California supplied practically the entire output of the United States for the half century dating back to the beginning of recorded production in 1850, which is given in another table. A complete table of production by States for the 63 years ending with 1912 is in preparation for publication in the Survey report on quicksilver for 1912.

## TONNAGE AND RECOVERY.

Producers reported 143,582 short tons of new ore mined and available for treatment in 1911, against 131,813 tons in 1910, of which 138,525 short tons of ore were treated against 123,562 tons in 1910. The average recovery was 11.5 pounds of metal per ton, or 0.575 per cent of ore treated, against 12.5 pounds, or 0.625 per cent of ore, in 1910.

In California 130,926 short tons were treated, against 115,306 tons in 1910, an average output in 1911 of 10.8 pounds of metal per ton, or 0.54 per cent of ore reduced, against a recovery of 10.3 pounds, or 0.515 per cent of ore, in 1910. In Nevada and Texas combined 7,599 short tons of ore were treated in 1911 and produced an average of 23.6 pounds of metal per ton, or 1.18 per cent of ore treated, against 8,256 tons treated in 1910, which produced 30.8 pounds of metal, or 1.54 per cent of ore.

The following table gives the tonnage treated and the recoveries, by States, in 1910 and 1911:

*Quicksilver ore treated and average recoveries, by States, in 1910 and 1911.*

| State. | 1910 | | | 1911 | | |
|---|---|---|---|---|---|---|
| | Short tons treated. | Pounds of metal recovered per ton. | Percentage of ore recovered as metal. | Short tons treated. | Pounds of metal recovered per ton. | Percentage of ore recovered as metal. |
| California | 115,306 | 10.3 | 0.515 | 130,926 | 10.8 | 0.54 |
| Nevada and Texas | 8,256 | 30.8 | 1.54 | 7,599 | 23.6 | 1.18 |
| Total and average for United States | 123,562 | 12.5 | .625 | 138,525 | 11.5 | .575 |

The average gross value of recovered metal per ton of ore treated in 1911 was $6.63 in California, $14.51 in Nevada and Texas combined, and $7.06 for the United States. This value for the United States was $7.75 in 1910 and $6.06 in 1909.

For the calendar year 1911 inquiries were made as to the methods of recovery, and some new data are available which show the insignificant production of quicksilver in the United States by the well-known retort method. Retorts for recovery of quicksilver are of two types, known as the pipe retort and the D retort. Both work on the same principle, that of distilling off the mercury from the ore separately from the gases of combustion and conveying the volatilized metal through short outside condensing pipes to a trough in which the mercury is collected. The retorts are themselves built over fire boxes, and are filled and discharged horizontally from the furnace floor, the D retort by means of iron pans resting on the flat bottom and the pipe retort by means of shovels and semicircular hoes. Retort plants contain from 1 to 15 or more retorts, are inexpensive to erect and operate, and may serve useful purposes in the early development of a mine, but are best used, perhaps, for treatment of concentrates or furnace soot. Unless very carefully operated, however, they menace the health of the workmen; and when in operation at new mines the temptation is to gouge out the rich ore of the mines, for which they are best adapted, and quickly sacrifice a property that might otherwise be remunerative if worked on a larger scale and by better methods.

The great bulk of present domestic output is from shaft furnaces, in which, as is well known, the descending ore meets the upward heated furnace flames and gases, and the volatilized metal passes with the gases and impurities of combustion into a series of condenser

chambers, usually of brick, in which the metal is collected and from which it is drawn off. The gases pass from the final chamber to the stack, usually through an inclined flue.

Quicksilver metallurgy has been highly perfected in California, and the best development is now observed in the various modifications of coarse-ore and fine-ore furnaces to be credited to California metallurgists. The modern tendency appears to be toward the increased use of the Hüttner tile furnace perfected by Robert Scott, formerly of the new Almaden mine, which is now adapted to both medium and fine ore. All the furnaces in Texas, and the new plant in Nevada, are of this type. At New Idria, also, are the coarse-ore furnaces designed by B. M. Newcombe, the well-known manager, and at the Guadalupe mine are the Davey modified Litchfield furnaces.

The following table shows the tonnage treated in retorts and in furnaces in 1911 and the recovery of metal in each type:

*Quicksilver ore treated in retorts and in furnaces in 1911, by States.*

| State. | Ore treated, short tons. | | Quicksilver recovered, flasks. | | Percentage of metal recovered per ton of ore treated. | |
|---|---|---|---|---|---|---|
| | Retorts. | Furnaces. | Retorts. | Furnaces. | Retorts. | Furnaces. |
| California | 262 | 130,664 | 139 | 18,721 | 2.0 | 0.5 |
| Nevada and Texas | 20 | 7,579 | 33 | 2,363 | 6.2 | 1.2 |
| Total United States | 282 | 138,243 | 172 | 21,084 | 2.3 | .6 |

On comparing this table with those preceding, it will be found that 99.8 per cent of the quicksilver ore treated in the United States in 1911 was originally supplied to shaft furnaces and produced 99.2 per cent of the total quicksilver recovered.

## DEPOSITS, ORES, AND GANGUES.

### GENERAL STATEMENT.

For detailed descriptions of domestic quicksilver deposits the reader should consult the considerable literature on the subject, references to which are given in this and preceding Survey reports. The following summary and generalizations are mainly for the benefit of those not needing details, or of miners, prospectors, and others to whom the literature may not be readily accessible. A more complete treatment of this subject is planned for a future report.

### DEPOSITS.

The quicksilver deposits of the United States are found in more or less simple fissure fillings, frequently irregular and linking together larger fillings or stockworks; in compound fracture zones; along bedding planes or other contacts, and along jointing planes; and disseminated in the adjoining rocks. The ore shoots are often extremely irregular and are sometimes lenticular. The ore and gangue occur as

fissure filling and often as cementing breccias, and the ore is also found impregnating the wall rock, in part possibly replacing it.

A considerable number of deposits have proved to be very superficial, decreasing rapidly in size and value with depth. The localization of such deposits, which may have been most closely allied with hot springs, may have been caused mainly by proximity to the surface at time of deposition; the localization of deeper and more extensive deposits seems mainly to have been determined by cross fractures or by barriers of impervious friction gouge or of impenetrable shales, quartzites, or igneous dikes. It is thought by the writer that a period of silicification preceded in part deposition of ore and that earlier solutions therefore rendered impervious walls which determined localization of ore deposits at a later date.

Many quicksilver deposits appear to lie along lines of regional fissuring, some of which are marked by mineral springs, active or extinct, and all gradations can be traced between cold deposits and hot springs.

The deposits are found in many kinds of igneous, sedimentary, and metamorphic rocks, of various ages from the Ordovician to late Tertiary, but in the United States, mainly in Cretaceous and Tertiary sedimentary rocks. The rocks invaded have been commonly altered, in part regionally and earlier than the period of ore deposition, in part locally and both earlier than and contemporaneously with the deposition of ore. Local alteration has been chiefly by leaching or silicification.

Granitic, quartz porphyritic, rhyolitic, andesitic, diabasic, and basaltic igneous rocks, limestones, sandstones, shales, serpentines, slates, and quartzite, are all found as the invaded or country rock of quicksilver deposition.

There is a striking relation between igneous activity and deposition of quicksilver ores. In the United States the volcanism at the close of the Tertiary, has probably been more active than that of any other period in forming quicksilver ores. However, many shallow quicksilver deposits may have been formed earlier and eroded away. Following great crustal breaks of the Pliocene were notable intrusions and extrusions marking manifestations of igneous activity along lines of weakness then formed; and following these and continuing as hot springs to the present day was the passage of mineral solutions, leaching or silicifying the fractured rocks and later depositing quicksilver and associated ores and gangue minerals.

Field studies indicate a more than accidental association of basaltic (and less often rhyolitic) volcanic rocks with quicksilver deposits in California and the Northwest, and of rhyolitic extrusives with those of the Great Basin region; and the prospector may find it useful to consider these associations, together with those of hot-spring deposits of opaline silica, the leaching, silicification, or serpentinization of country rock, and the presence in fissure filling of the ore and gangue minerals apparently favoring these deposits. No rules, however, should be expected to be infallible in prospecting; neither basalt nor rhyolite has yet been recorded from the immediate vicinity of the New Idria mine, at present the largest producer in America. This deposit is a striking exception that does not weaken the general rule, and indeed basalt is only a few miles away and may yet be found nearer the mine.

## ORES.

The mercurial minerals, although few of them are of commercial importance, so far as known, are briefly listed below:

Native mercury, or quicksilver, as is well known, is a tin-white metal, fluid at ordinary temperatures, freezing at 40° C. and vaporizing at 350° C. It is usually pure in its native state, but sometimes contains small traces of amalgams of other metals. It is found in the mines in minute globules in the gangue and rock, rarely collecting in considerable quantities in cavities. It has also been found in California as a deposit from waters of hot springs which were conducted through pipes to baths of a health resort.[1]

Native quicksilver has generally been considered a secondary product by reduction of cinnabar and metacinnabarite, but it may yet be shown that some quicksilver is primary.

Amalgam is a mercury-silver mineral with the formula AgHg and varying from $Ag_2Hg_3$ to $Ag_{36}Hg$. It is silver white, with a hardness of 3 to 3.5 and specific gravity of 13.75 to 14.1. It crystallizes in the isometric system and is also massive; it is brittle to malleable; and it varies from ordinary amalgam (formula $Ag_2Hg_3$) through the variety arquerite (formula $Ag_{12}Hg$) to the variety kongsbergite (formula $Ag_{36}Hg$). It is found in Europe, South America, and British Columbia, and in the La Plata district, Colorado.

Lehrbachite is a selenide of lead and mercury (PbSe + HgSe). It is found massive and granular, is brittle, is lead-gray to iron-black in color, and has specific gravity of 7.8. It occurs in the Harz Mountains, Germany.

Metacinnabarite is mercuric sulphide like cinnabar and has the same formula HgS (with 86.2 per cent of quicksilver when pure), is generally massive, is grayish-black in color, and has a black streak. It is brittle, has hardness of 3 and specific gravity of 7.8. It has been found as an ore of quicksilver in California mines, and in Mexico, Germany, and New Zealand.

Guadalcazarite is a variety of metacinnabarite including a little zinc and selenium. It occurs massive, with hardness of 2 and gravity of 7.15, and is found as an ore with cinnabar, barite, and quartz at Guadalcazar, Mexico.

Leviglianite is a variety of guadalcazarite with iron and is found in Italy.

Tiemannite is the selenide of mercury with formula HgSe, hardness 2.5, gravity 8.19, metallic luster, steel-gray to blackish-gray color, and black streak. It crystallizes with tetrahedral forms in the isometric system, and is brittle. Analyses indicate the presence of both sulphur and cadmium, but these are probably not essential. It has been found in Germany, rarely in California, but especially at the Lucky Boy mine, Piute County, Utah, with barite, manganese oxide, and calcite, where it was mined for a brief period as an ore.

Onofrite is the sulphoselenide of mercury with formula Hg(S, Se) and may be considered intermediate between metacinnabarite and tiemannite. It is found massive or fine granular, is brittle, with hardness 2.5, gravity 8.0, metallic luster, and color and streak blackish gray. Analyses of the mineral have shown small quantities of zinc and manganese, but these are probably nonessential. It occurs with

[1] Forstner, William, oral communication to the writer.

calcite and barite at San Onofre, Mexico, and was mined as an ore with tiemannite in Utah.

Coloradoite is mercuric telluride (formula HgTe), is massive or granular, and has the hardness 3, specific gravity 8.6, a metallic luster and iron-black color turning to gray. It occurs sparingly with gold, sylvanite, native tellurium, and quartz in Colorado and somewhat abundantly in Western Australia.

Kalgoorlite and coolgardite are mixtures of gold, silver, and mercury tellurides, found at Kalgoorlie in the East Coolgardie goldfield, Western Australia, and are not distinct mineral species.

Cinnabar, the chief ore of quicksilver, and in the United States at present almost the only ore worked on a commercial scale, is the well-known, brilliantly beautiful, cochineal-red, mercuric sulphide. Its formula is HgS, and when pure it contains 86.2 per cent of mercury. It crystallizes in the rhombohedral system in trapezohedral forms like quartz, sometimes in twins, occasionally in thick tabular forms, and also in acicular prismatic forms. It is found in crystalline incrustations, intergrowths, and impregnations, and also granular, massive, or earthy. It has perfect prismatic cleavage, uneven subconchoidal fracture, is somewhat sectile, has the hardness 2 to 2.5 and gravity 8.0 to 8.2. Its luster is adamantine, inclining to metallic when dark colored and to dull in friable varieties. The color is characteristically cochineal red, but may be brownish red and even lead-gray when impure, as it frequently is from admixture of clay, iron oxide, or bitumens. The streak is scarlet. The ordinary pure variety is crystallized, massive, or earthy, and bright red to reddish brown in color; the hepatic (impure mineral) is liver-brown in color. Cinnabar occurs as the chief ore practically wherever quicksilver is mined. Its most common associates in ores among metallic minerals are pyrite and marcasite, sulphides of antimony and arsenic, sulphur, and much less often sulphides of copper and native gold; among gangue minerals are calcite, silica (as quartz, opal, and chalcedony), barite, bitumens, and less frequently fluorite.

Livingstonite, a mercury sulphantimonite, with formula $HgSb_4S_7$, is found in groups of slender prismatic crystals, also columnar massive resembling stibnite, has the hardness 2 and gravity 4.81, a metallic luster, bright lead-gray color and red streak. It occurs at Huitzuco, Mexico, in a matrix of calcite and gypsum, with sulphur, cinnabar, stibnite, and valentinite. It is also found at Guadalcazar.

Schwatzite, the mercurial tetrahedrite (formula $4(Cu_2Hg)S, Sb_2S_3$, according to Brush and Penfield), in which mercury replaces part of the copper of the antimonial tetrahedrite, is dark gray to iron-black, often with dull luster, and with gravity about 5.1. It occurs in Hungary, where it has produced quicksilver as a by-product, in Italy, and in the Blue Mountains of Oregon.[1] It is probably more common than generally supposed. It has been suggested by Lindgren that schwatzite was the original ore whose decomposition formed the present mercurial ores in the Plomosa mining district near Quartzsite, Ariz.[2] It would seem also that schwartzite was among the original ores of the La Plata district, in which W. H. Emmons[3] found native quicksilver, amalgam, and a mercury sulphide, probably

[1] Lindgren, Waldemar, oral communication to the writer. See also Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 2, 1901, p. 683.
[2] See Bancroft, Howland, Bull. U. S. Geol. Survey No. 430, 1910, p. 153.
[3] See Bull. U. S. Geol. Survey No. 260, 1905, pp. 123–127.

cinnabar, associated with sulphides, tellurides, sulphantimonites, and sulpharsenites. Among its alteration products are cinnabar, amalgam, and the various secondary copper minerals, chalcopyrite, malachite, azurite, and covellite.

Calomel, or horn quicksilver, the mercurous chloride ($Hg_2Cl_2$), crystallizes in the tetragonal system, often in tabular crystals, has a rather distinct cleavage, a conchoidal fracture, is sectile, with a hardness of only 1 to 2, has the gravity 6.5, an adamantine luster, and is translucent to subtranslucent. In color it is white, yellowish to ash-gray, yellowish-white to brown. The streak is pale yellowish-white. Calomel is found sparingly in the quicksilver mines of Germany, Spain, Hungary, Italy, Servia, Mexico, and Texas. It is considered secondary, probably after cinnabar, with which it is associated.

Terlinguaite, a rare oxychloride (formula $Hg_2ClO$), has been found in small monoclinic prismatic crystals, with brilliant adamantine luster and perfect cleavage. It is brittle to sectile. The color of the crystals is sulphur-yellow with slight greenish tinge, and of the powder lemon-yellow, both becoming olive-green on exposure. It occurs with calomel, eglestonite, montroydite, kleinite, and mosesite, all in small quantities, in shallow workings of the deposits at Terlingua, Tex., and all these minerals are probably secondary.

Eglestonite, the mercurous oxychloride, $Hg_4Cl_2O$, is of the isometric system, crystallizing in minute dodecahedral forms, without cleavage, and with uneven fracture. It is brittle, has the hardness 2 to 3 and gravity 8.3. The luster is brilliant adamantine to resinous, the color brownish yellow to yellowish brown, darkening on exposure to sunlight and finally becoming black. The powder when fresh is greenish yellow to canary yellow. The crystals are transparent. It occurs with terlinguaite.

Kleinite, a mercury ammonium chloride of uncertain formula, is of the hexagonal system, in short prismatic crystals, is brittle, has the hardness 3.5 and gravity 7.9, and is yellow to orange color, which darkens on exposure to light but is regained in the dark. It occurs with terlinguaite.

Mosesite, another mercury ammonium chloride, crystallizes in small octahedra of the isometric system, and has imperfect cleavage, uneven fracture, hardness slightly above 3, adamantine luster, rich lemon to canary-yellow color, and very pale yellow powder and streak. It is translucent and does not lose color on exposure to light. It occurs with terlinguaite.

Tocornalite is an iodide of silver and mercury, occurring granular to massive, with pale-yellow color becoming darker on exposure, and a yellow streak. It is found in Chile.

Coccinite is an uncertain mineral originally described as an iodide of mercury, but apparently containing chlorine or selenium rather than iodine. It has been found in Mexico in particles of a reddish-brown color, adamantine in luster, on selenide of mercury; is both massive and in transparent to translucent acute, acicular, rhombic pyramids of fine red to yellow color, sometimes yellowish-green changing to gray to dark-green on exposure.

Montroydite, mercuric oxide (formula HgO), is found in minute highly modified prismatic crystals of the orthorhombic system, and also forms velvety crusts. It is transparent, brittle, has the hardness 1.5 to 2, gravity undetermined, luster adamantine to vitreous,

orange-red color, and streak the same color but lighter. It occurs sparingly with terlinguaite.

Ammiolite is of doubtful composition, but is regarded as antimonate of copper mixed with cinnabar and other impurities. It contains antimony, copper, mercury, sulphur, and iron. It occurs as an earthy powder, with deep red to scarlet color. It is found in many of the mines of Chile, filling cavities in the quartzose or argillo-ferruginous gangue of schwatzite and in the pores of the imperfectly compact mercurial tetrahedrite itself, and is a secondary mineral arising from decomposition of this ore.

Barcenite, another sulphur-antimony-mercury mineral (but without copper), of doubtful composition, is found massive, or with structure finely granular, compact, or porous, and also columnar. It has tolerably even fracture, is brittle, has the hardness 5.5 and gravity 5.3, is of a dull luster, and is earthy and sometimes resinous. The color is dark-gray to nearly black and the streak is ash-gray with slight greenish tint. Barcenite is found at Huitzuco, Mexico, associated with livingstonite from which it is an alteration product.

Magnolite, with formula probably $Hg_2TeO_4$, is found in white radiating tufts of very minute white, acicular, or capillary crystals, with silky luster. It is a decomposition product of coloradoite and is found rarely in the Magnolia district, Colorado.

*Associated metallic minerals.*—The metallic minerals associated with mercurial minerals in quicksilver ores are predominantly the sulphides of iron, pyrite or marcasite, less frequently the sulphides of antimony and arsenic, and much less frequently the sulphides of nickel, copper, lead, zinc, and silver, the oxides of manganese, and free sulphur and gold. The oxidation products of these sulphides occur in upper weathered portions of the deposits in proportion to their sulphides. Among the most common is limonite.

### GANGUE MINERALS.

Aside from fresh and altered brecciated country rock and minerals of the wall rocks, the most common gangue minerals of quicksilver deposits are forms of silica (found as vein and massive quartz, chalcedony, jasper, chert, and opal), and calcite or dolomite. Silica in one or more forms and calcite are found in a large majority of the deposits. Less often are found barite and aragonite, and quite rarely fluorite and borax. Gypsum frequently occurs, probably mainly as a secondary mineral. Bitumens of various forms have been found, and both marsh gas and carbon dioxide have been met in quicksilver mines, the former in the New Idria mine and the latter (as reported) in Idaho.

## RESOURCES, OCCURRENCES, AND DEVELOPMENTS, BY STATES.

### ARIZONA.

There was no production of quicksilver reported from Arizona in 1911. In the Plomosa mining district, in Yuma County, are the properties of the Cinnabar Development Co., successor to the Colonial Mining Co., described by Bancroft[1] in the report on quicksilver for 1910.

[1] Bancroft, Howland, Notes on the occurrence of cinnabar in central western Arizona: Bull. U. S. Geol. Survey No. 430, 1910, pp. 151–153.

The occurrence of quicksilver in Arizona is also mentioned without further information by Blake [1] in or near Skull Valley, west of Prescott, in Yavapai County, and in calcite veins at Rye, in Gila County. Cinnabar in place is also reported in Copper Basin, in Yavapai County.[2]

There is no present prospect for material addition to the quicksilver supply from Arizona.

## CALIFORNIA.

The references to the literature on the geology, mining, and metallurgy of quicksilver are many and will be found in the bibliography at the end of the Survey report on quicksilver for 1910[1] and brought to date in this report.

The most useful general discussions of quicksilver in California are contained in the monograph by Becker [3] and the bulletin by Forstner,[4] and these books should both be consulted by anyone investigating the subject.

The quicksilver industry in California was characterized by unusual activity in 1911, as shown by the increased development and production and by the construction work upon new furnaces.

The production of quicksilver in California in 1911 was 18,860 flasks, valued at $867,749, an increase, as compared with the output for 1910, of 1,649 flasks in quantity and of $67,265 in value, and, as compared with the production of 1909, an increase of 2,782 flasks in quantity and of $137,004 in value. It was in fact the largest output since 1906 and the most valuable since 1905. In 1911 California furnished 88.7 per cent of the total production of the United States against 83.5 per cent in 1910 and 76 per cent in 1909. The following table shows the production of California, by years, since 1850:

*Total production of quicksilver in California, 1850–1911, in flasks.*[5]

| | | | | | |
|---|---|---|---|---|---|
| 1850 | 7,723 | 1872 | 31,621 | 1894 | 30,416 |
| 1851 | 27,779 | 1873 | 27,642 | 1895 | 36,067 |
| 1852 | 20,000 | 1874 | 27,756 | 1896 | 30,765 |
| 1853 | 22,284 | 1875 | 50,250 | 1897 | 26,691 |
| 1854 | 30,004 | 1876 | 72,716 | 1898 | 31,092 |
| 1855 | 33,000 | 1877 | 79,395 | 1899 | 29,454 |
| 1856 | 30,000 | 1878 | 63,880 | 1900 | 26,317 |
| 1857 | 28,204 | 1879 | 73,684 | 1901 | 26,720 |
| 1858 | 31,000 | 1880 | 59,926 | 1902 | 28,972 |
| 1859 | 13,000 | 1881 | 60,851 | 1903 | 30,526 |
| 1860 | 10,000 | 1882 | 52,732 | 1904 | 29,217 |
| 1861 | 35,000 | 1883 | 46,725 | 1905 | 24,635 |
| 1862 | 42,000 | 1884 | 31,913 | 1906 | 20,310 |
| 1863 | 40,531 | 1885 | 32,073 | 1907 | 17,431 |
| 1864 | 47,489 | 1886 | 29,981 | 1908 | 16,984 |
| 1865 | 53,000 | 1887 | 33,760 | 1909 | 16,078 |
| 1866 | 46,550 | 1888 | 33,250 | 1910 | 17,211 |
| 1867 | 47,000 | 1889 | 26,464 | 1911 | 18,860 |
| 1868 | 47,728 | 1890 | 22,926 | | |
| 1869 | 33,811 | 1891 | 22,904 | Total | 2,104,218 |
| 1870 | 30,077 | 1892 | 27,993 | | |
| 1871 | 31,686 | 1893 | 30,164 | | |

[1] Blake, W. P., Minerals of Arizona, their occurrence and association: a report to the governor of Arizona, Tucson, 1909, p. 15.
[2] Eng. and Min. Jour., Oct. 24, 1899.
[3] Becker, G. F., The geology of the quicksilver deposits of the Pacific slope: Mon. U. S. Geol. Survey, vol. 13, 1888.
[4] Forstner, William, The quicksilver resources of California: Bull. California State Min. Bur. No. 27, 1903.
[5] 76½ pounds net; 75 pounds net since June 1, 1904.

The total value of the quicksilver production of California from the first recorded output in 1850 to the end of 1911, based on the yearly production and the best obtainable annual average price per flask, may be estimated at $94,412,661. The highest annual value of the production in this period of 62 years was $4,228,538 in 1875, when the output was 50,250 flasks of 76½ pounds each and the average annual price was $84.15 per flask, and the lowest value was $535,500 in 1860, when the output was estimated at 10,000 flasks of 76½ pounds each and the average annual price was $53.55. For the period considered the average annual value of the production has been $1,522,785; the average annual output, 33,939 flasks; and the average annual price, $44.87 per flask as sold, whether of 76½ or of 75 pounds net each. The highest average annual price per flask was $105.18 in 1874, and the lowest was $28.23 in 1882.

The output of quicksilver in 1911, as compared with that of 1910, was reduced in Lake, Napa, San Benito, San Luis Obispo, and Trinity counties, was increased slightly in Sonoma County and very materially increased in Santa Clara County. A small output was reported from Colusa and Santa Barbara counties in 1911, against none in 1910, and no production was reported from Eldorado, Fresno, King, Mendocino, Monterey, Siskiyou, Solano, Stanislaus, and Yolo counties in either year. In 1911, as in 1910, the county leading in production was San Benito, in which is the New Idria mine, the most important producer of recent years in the western hemisphere; and the next county in rank of output was Santa Clara, in which is the New Almaden mine, which has made the greatest total output in the country to date, and the Guadalupe mine, which was the second largest producer in the United States in 1911. Third in rank in each year was Lake County.

Twenty-seven quicksilver mines produced in California in 1911, but of these 5 produced ore in development but no metal and 4 produced quicksilver from old dumps or clean-up of old furnaces but made no output of ore. The total tonnage of ore mined in the State in 1911 was 131,336 short tons, against 119,072 tons in 1910 and 158,623 tons in 1909. There were treated in 1911 in California 130,926 tons of ore and old material, against 115,306 tons in 1910 and 144,989 tons in 1909. Of the tonnage treated in 1911 retort furnaces received 262 tons, producing 139 flasks of quicksilver, and shaft furnaces received 130,664 tons, yielding 18,721 flasks. The average recovery of metal from ore in California in 1911 was 10.8 pounds per ton of ore treated, against 10.3 pounds in 1910, or about 0.5 per cent of the ore in each year, and against 8 pounds, or 0.4 per cent, in 1909. The average percentage of the crude ore treated recovered as metal was 2 per cent from retorts in 1911 and 0.5 per cent from shaft furnaces.

The production of quicksilver in California in 1909, 1910, and 1911, is shown by counties in the following table:

*Production of quicksilver in California, by counties, during 1909, 1910, and 1911, in flasks of 75 pounds.*

| County. | 1909 | | 1910 | | 1911 | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Colusa | 17 | $773 | | | [a] 84 | [a] $3,864 |
| Lake | 1,065 | 48,404 | 1,148 | $53,394 | 829 | 38,143 |
| Napa | 1,670 | 75,901 | 621 | 28,883 | 267 | 12,285 |
| San Benito | 8,900 | 404,505 | 10,804 | 502,494 | 9,809 | 451,312 |
| San Luis Obispo | 370 | 16,817 | [b] 533 | 24,790 | 244 | 11,226 |
| Santa Clara | 3,522 | 160,075 | 4,038 | 187,807 | 7,533 | 346,593 |
| Sonoma | 344 | 15,635 | 67 | 3,116 | 94 | 4,325 |
| Trinity | 190 | 8,635 | [b] | [b] | [a] | [a] |
| Total | 16,078 | 730,745 | 17,211 | 800,484 | 18,860 | 867,749 |

[a] Colusa, Santa Barbara, and Trinity combined for 1911.
[b] San Luis Obispo and Trinity combined for 1910.

*Colusa County.*—The Manzanita mine, in the Sulphur Creek district of Colusa County, made a nominal output from pipe retorts in 1911. The Ruby-King property carries a little quicksilver but is now being developed as a mineral-paint mine.

*Eldorado, Fresno, and Kings counties.*—There was no production of quicksilver in Eldorado, Fresno, and Kings counties in 1911, but the Pacific Quicksilver Co., operating in the Little Panoche district in Kings County near South Dos Palos on the Merced-Kings County line, began the erection of furnace and condenser in October, 1911.

*Lake County.*—In Lake County there was no output of quicksilver by the Chicago mine, but the erection of a 15-ton Scott furnace was reported almost completed. At the Great Western mine there was a recovery of metal from the old furnace and condensers, but as the mine has been permanently closed and the furnaces are now torn down no further output is expected from this source. At the Wall Street mine a small tonnage of ore and concentrates was produced and treated in D retorts and a new compressor plant was put up. At the Helen mine a considerable tonnage was extracted and treated in a 50-ton Scott furnace, the final recovery being mainly from furnace soot which was treated in D retorts. These mines are all in the Mayacmas district. No activity was reported from the Clear Creek or Sulphur Lake districts in Lake County in 1911.

There were 6,035 short tons of ore mined and treated in Lake County in 1911, against 1,630 tons mined and 630 tons treated in 1910. The production in 1911 was 829 flasks of quicksilver, valued at $38,143, from the treatment of 35 tons in retorts and 6,000 tons in furnaces, and from the recovery at the dismantled plant of the Great Western mine. The total recovery in 1910 was 1,148 flasks, valued at $53,394, and in 1909 the output was 1,065 flasks, valued at $48,404.

*Mendocino and Monterey counties.*—No quicksilver was produced in Mendocino or Monterey counties in 1911. At the Pitts mine near Parkfield in Monterey County, a 20-ton Scott furnace was in prospect and considerable ore was reported mined in 1911.

*Napa County.*—In Napa County there was a small recovery at the Aetna mines in 1911 from the old condensers, and considerable development work was done. The Knoxville mine was again a pro-

ducer, but the plant was reported inactive the greater part of the year for lack of fuel, although prospecting for new ore bodies was carried on. At the Twin Peaks property a small quantity of ore was extracted during assessment work and treated in retorts. The Bella Union and Oakville mines were idle owing to litigation, but were in prospect of production in 1912. The La Joya mine, equipped with a 10-ton Fitzgerald furnace and a 1-ton retort plant, and other mines in Napa County were idle throughout the year. The Napa Consolidated mine has been permanently closed down, the plant has been dismantled, and production from this well-known property has ceased.

There were 408 tons of ore mined in Napa County in 1911, and 132 tons were treated which yielded 267 flasks of quicksilver, valued at $12,285. In 1910 the output was 621 flasks, valued at $28,883, and in 1909 the production was 1,670 flasks, valued at $75,901.

*San Benito County.*—In San Benito County a small quantity of ore was extracted at the Florence Mac mine near Lone Oak, but the single pipe retort was not operated. Work was also done in prospecting the Tiger claim near Hernandez. The Alpine property was considerably developed and toward the end of the year a run of the new battery of 12 D retorts, treating 4 tons of ore per day, resulted in a small output of quicksilver. The Aurora mine of the Esmeralda group, in the New Idria district, was also actively developed, and a small output of metal came from the operation of an old retort. A new rotary furnace was completed and is expected to be operated in 1912. The Archer property about 10 miles southeast of New Idria was developed and an output was made from a pipe retort. There was little work done at the Bradford mine, which is equipped with a 6-ton Scott furnace.

The New Idria mine continued its prosperous career and remained the most important quicksilver producer in America. The mine was briefly described in the Survey report on quicksilver in the United States in 1908.[1] The property is equipped with one 60-ton Scott furnace and two 80-ton coarse ore furnaces of the Newcomb type designed by the present general superintendent. The furnaces were operated throughout the year, treating 67,706 tons of ore, according to the published annual report for the calendar year 1911, and producing 9,750 flasks of quicksilver. In 1910 the tonnage treated was 73,208 short tons and the output of metal was 10,800 flasks. In 1911, however, the development work of drifts and tunnels aggregated 3,167 feet against 2,456 feet in 1910. The dividends paid were $150,000 in 1911 and $160,000 in 1910. In development work, according to the published annual report, all rock above level 1 was broken from below, working up to the surface. Above levels 1, 2, and 3 considerable work was done on the east end of the mine and some on the west end. Above level 1, in space A, there is yet considerable ore and here also is the New Hope vein from which came some rich ore. Considerable work was done to the west with fair results. Above level 2, space B, there has been fair ore to the east but little work to the west. Above level 3, space C, a large amount of work has been done at the east end, but little at the west, leaving much ground here to be prospected later. Above

[1] McCaskey, H. D., Quicksilver: Mineral Resources U. S. for 1908, pt. 1, U. S. Geol. Survey, 1909, pp. 686–689.

level 4, in space D, considerable good ore is showing in the west, while to the east the ore is largely worked out. Above level 5, space E, much work has been done, and in the upper portion a large, good stope is being worked, leaving, however, a large extent of ground to be opened out. Above level 6, space F, no work is being done, but this area will be prospected from below on the east end later. Space G, of level 7, will also be opened up by an east raise now going up from level 10. Above level 7, in space H, there is a body of good ore to the west, and on the east side is a stope coming up from level 9 in fair ore in sandstone. Above level 9, space I, work was done in drifting east and working the stope in sandstone, also in drifting west for the ore shoot showing above. Above level 10, in space J, two stopes have been opened on the east, and to the west colors show along the level. From east to west is about 900 feet. Operations in opening up the San Carlos mine of the company were continued from the northwest at Molinos Peak with promising outlook, and this work will be pushed in 1912.

The total quantity of ore reported as mined in San Benito County in 1911 was 69,066 short tons, and the total output of quicksilver was 9,809 flasks, valued at $451,312, from the treatment of 67,776 tons of ore. In 1910 the quantity of ore mined was 73,510 short tons, that treated was 73,211 tons, and the recovery was 10,804 flasks, valued at $502,494. The average recovery of metal for the county was 11.02 pounds of quicksilver per ton treated, or 0.55 per cent of the ore, in 1910, and 10.85 pounds, or 0.54 per cent, in 1911. The ore treated in 1911 yielded a slightly lower recovery per ton than in 1910, but a slightly higher recovery than that of 1909.

*San Luis Obispo County.*—There was no production of quicksilver reported from the Pine Mountain or San Carpojo Creek districts in San Luis Obispo County in 1911. In the Pine Mountain district, however, development work and a nominal extraction of ore were reported from the Doty mine and a 5-pipe, 1-ton retort was in prospect of erection. Development work only was reported from the Hamilton mine. In the Adelaide district the 50-ton Scott furnace of the Oceanic mine produced quicksilver during part of the year from ore extracted in development work. The ore yields about 10 pounds of metal per ton treated. The Cambria mine remained shut down, but is expected to reopen in 1912; and the old Klau, now the Sierra Morena, was inactive owing to destruction of the plant by fire, but a nominal output resulted from a clean-up of old condensers. The retorts at the Libertad mine were idle, but development work was reported there and also at the Josephine mine. Just east of the Klau mine the Capitoa prospect was being developed with reported favorable showing and a D retort plant was in course of erection. The Rinconda mine resumed production in 1911 from the treatment of a small quantity of ore in retorts.

*Santa Barbara County.*—In Santa Barbara County work at the Bully Boy property was suspended owing to shortage of funds, and development work only was reported from the Copper King and Acachuma mines. At the Prietos mine a small production was made. Each of these properties, except the Copper King, is equipped with retorts for treating the ore.

*Santa Clara County.*—Development work was reported at the Miller property in Santa Clara County, but the Phoenix mine, equipped

with a 50-ton Scott furnace, was idle and the Santa Teresa is abandoned. The San Juan property was not worked, but is expected to be operated in 1912. The Guadalupe mine, equipped with two 18-ton coarse-ore furnaces, and two 30-ton Davey fine-ore furnaces, yielded an increased production in 1911 and ranked second in output in the United States. The famous New Almaden mine, which has made the largest quicksilver production to date in the country, yielded an important output in 1911 also. The mine is equipped with fine, medium, and coarse-ore furnaces with a total daily treatment capacity of 168 tons.

In Santa Clara County 49,277 short tons of ore were mined and 54,893 tons were treated in 1911, with a yield in quicksilver of 7,533 flasks, valued at $346,593. In 1910 the production was 4,038 flasks, valued at $187,807, from 35,442 tons treated, and in 1909 it was 3,522 flasks, valued at $160,075, from 39,971 tons treated. The recovery per ton treated in 1911 was 10.29 pounds of metal, or 0.5 per cent of the ore, against 8.54 pounds of metal, or 0.4 per cent, in 1910, and 6.61 pounds of metal, or 0.3 per cent, in 1909. The average grade of ore treated in Santa Clara County has therefore been on the increase of late.

*Siskiyou and Solano counties.*—No operations were reprted in quicksilver mining in Siskiyou County in 1911. In Solano County, although a considerable tonnage of ore was reported as mined in development work on level 6 at the St. John mine, the continuous furnace and the pipe retort with which the mine is equipped were not operated.

*Sonoma County.*—In the Mayacmas district in Sonoma County the Culver-Baer and the Cloverdale groups were both producers in 1911, but the Socrates and other mines in the county were not operated. At the Culver-Baer a 10-ton coarse-ore furnace has been erected, but it was found that the ore was breaking too fine for successful treatment in this furnace, and a 20-ton Scott fine-ore furnace was completed toward the end of the year. At the Cloverdale group reduction of the ore is by an incline tile furnace with reverberatory hearth.

The total production reported from Sonoma County in 1911 was 900 tons of ore mined, 350 tons treated, and 94 flasks of quicksilver, valued at $4,325, recovered. In 1910 the recovery was 67 flasks, valued at $3,116, and in 1909 it was 344 flasks, valued at $15,635.

*Stanislaus County.*—In Stanislaus County there was a small output of ore from the Newhall mine in the Deer Park district, where considerable promising development was done.

*Trinity County.*—In Trinity County there was a small output of quicksilver from the Altoona mine, but there was no output from the Integral property.

*Yolo County.*—No operations of any kind in quicksilver mining took place in Yolo County in 1910 or 1911.

## IDAHO.

Although no production of quicksilver in Idaho has been reported, the occurrence there of cinnabar, the principal ore of the metal, is of considerable interest. Details of the geologic field relations are lacking. The following notes are mainly from information furnished to the writer by Mr. R. C. Bell, State mine inspector of Idaho.

Several years ago in Blaine County, at Deer Creek, about 7 miles north of Hailey, a crosscut driven through limestone to intersect a lead-silver vein cut an irregular pipe-shaped shoot of brecciated limestone and calcite richly colored by cinnabar. At the intersection of fissures in the rock and several hundred feet below the surface, gas "in which a candle would not burn" flowed from the fissures into the workings according to report. There has been no subsequent development, it seems, and the impression appears to be that the average grade of the ore was low, although "specimen ore" carrying 10 to 20 per cent of metal was obtained, and that the ore shoot was ill defined.

In Custer County, at the Willis placers on Stanley Creek, cinnabar has been found for some time in the gold gravels, occurring, according to reports, as grains, pebbles, and bowlders up to 3 pounds in weight, of nearly pure mineral. The dredge operations have extended for over a mile up the creek, disclosing increasing quantities of cinnabar. The bed rock is said to be granite cut transversely to the stream course by porphyry dikes, some of which show gold and one of which, a mile above the present operations, is thought to be the origin of the cinnabar float. The clean-up boxes are reported to show monazite, corundum, magnetite, and ilmenite, along with gold and cinnabar. Cinnabar ore in place has not yet been located.

In Elmore County, in the Pine mining district, about 40 miles north of Mountain Home, a station on the Oregon Short Line, stringers of cinnabar are reported in granite at the contact of a porphyry dike.

In Idaho County, on Sugar Creek, about 10 miles east of Roosevelt, is the Pringle-Smith cinnabar prospect, said to be the most promising quicksilver deposit yet found in Idaho. The ore is reported to average 2 per cent of metal and to lie in lens-shaped shoots in granular igneous rock which appears to be intrusive in metamorphic sediments and in turn cut by porphyry dikes. The development is confined to shallow surface cuts and short tunnels. The gangue is said to be brecciated country rock and the ore is a portion of the cementing material. The deposits are reported to have produced handsome "specimen ore," and to show pay streaks averaging 10 per cent of quicksilver.

## NEVADA.

Figures of output of quicksilver in Nevada and Texas have been combined for both States for 1911 in order to conceal individual production. The output reported from the producers of both States combined for 1911 was 12,246 short tons of ore mined, 7,599 tons of ore treated, and 2,396 flasks of quicksilver, valued at $110,240, recovered. In 1910 the mines of Nevada alone produced 320 tons of ore, of which 35 tons were treated and yielded 70 flasks of quicksilver, valued at $3,256; and in 1909 Nevada and Oregon (combined to conceal individual output) yielded 2,176 tons of ore, of which 406 tons treated yielded 809 flasks of quicksilver, valued at $36,769. Increased output may be expected from Nevada in 1912. The first modern Scott furnace built in Nevada was completed at the Mercury mine near Ione, in Nye County, toward the end of 1911, and a considerable output may be looked for from this source.

Cinnabar is more widely scattered in the State than was at first thought and prospecting in 1911 has been reported promising. A brief summary of the chief occurrences, whether of commercial impor-

tance or not, is given below for the benefit of prospectors and others to whom the literature is not readily accessible.

*Esmeralda County.*—There has been no output of quicksilver from Esmeralda County, but Ransome has reported the occurrence of cinnabar, 1½ miles east of Black Butte, in the Goldfield district.[1] The cinnabar rock outcrops on the Brooklyn claim, but according to Ransome the ore is not found in the gold deposits. The mineral is in crystalline aggregates up to an inch in diameter rather abundantly disseminated through material that was probably once andesite or andesite tuff but which has been altered to cryptocrystalline secondary quartz, mottled with cinnabar and limonite. The presence of cinnabar in the Goldfield region, which is also characterized by the presence of abundant antimony, bismuth, and tellurium, extremely rich gold ores, and other field relations showing igneous activity and suggesting deposition at relatively shallow depth, indicates origin genetically related with volcanic processes for both cinnabar and gold.

In the Silver Peak district, about 10 miles north of Silver Peak, lies a deposit of alum and sulphur in which bright red stains thought to be cinnabar are associated with the sulphur and alum.[2] The occurrence is in highly altered rhyolite, and with the other minerals gypsum is also found. The association suggests solfataric action, and if the dying phase of volcanism was characterized by hot waters the apparent absence of deposits of silica show the solutions to have differed in content from those forming other cinnabar deposits in Nevada in which deposition of silica with cinnabar is usually characteristic. The deposit of cinnabar at this place is apparently of little economic importance.

*Humboldt County.*—Ransome[3] mentions the occurrence of particles and even of bowlders of cinnabar in the gold placer gravels of American Canyon, Humboldt County, on the east side of the Humboldt Range and about 2 miles south of Fitting, or Spring Valley, a town lying about 15 miles due east of Oreana, on the Southern Pacific Railroad. This led to prospecting for cinnabar lodes and development work was done at two places on the north side of the canyon, at one of which, 2 or 3 miles upstream from the mouth of the canyon, little specks of cinnabar were found in a soft, crushed, kaolinized zone about 6 feet wide, in porphyritic rhyolite, dipping north into the hill about 15° or 20°. At the time of Ransome's visit in 1908 an incline 200 feet long had been sunk and considerable drifting done. Another deposit, not visited by Ransome but said to be more promising, is a short distance north of the settlement of American Canyon, and is reported to be in limestone in a vein striking northwest and dipping 20° S. W., with eruptive rock as a hanging wall. Specimens contained abundant cinnabar in small irregular fissures in dark-gray limestone. The vein is said to have been traced for a length of 3,500 feet and to have been opened to a depth of 350 feet. Development work has been reported to the Survey on these properties for several years, and a small output of quicksilver has been made from the district from concentrates treated in pipe retorts.

[1] Ransome, F. L., Emmons, W. H., and Garrey, G. H., The geology and ore deposits of Goldfield, Nev.: Prof. Paper U. S. Geol. Survey No. 66, 1909, pp. 108, 113.

[2] Spurr, J. E., Ore deposits of the Silver Peak quadrangle, Nevada: Prof. Paper U. S. Geol. Survey No. 55, 1906, pp. 157–158.

[3] Ransome, F. L., Notes on some mining districts in Humboldt County, Nev.: Bull. U. S. Geol. Survey No. 414, 1909, p. 37.

There has been some prospect of the erection of larger furnaces at this place.

The Ruby cinnabar mine is in Eldorado Canyon, about 6 miles southeast of Humboldt House and on the northwest slope of Star Peak, in the northwestern portion of the Humboldt Range, according to Ransome.[1] The ore is in a dark limestone, presumably Triassic, and has been opened by superficial tunneling. The beds dip generally to the west, but at the mine they are much disturbed. The cinnabar is irregularly distributed in little veinlets and specks, and in part has filled fractures and in part replaced the crushed and fractured limestone. The average tenor of the ore body is reported to be about 2 per cent of quicksilver. Some of the material through which the veinlets of cinnabar ramify is nearly black, earthy in appearance, and of high density, and is found under the lens to be crowded with minute specks of cinnabar and of pyrite or marcasite. The presence of metacinnabarite (the black sulphide of mercury), is suggested but not practicable of verification in so fine-grained a mixture of sulphides. The limestone adjacent to the ore is minutely fissured and faulted, contains many open crevices, especially under the ore body, evidently much of it has been removed by solution, and the fracturing noted in connection with the deposition seems due to collapse of the rock overlying the solution cavities. The workings in 1908 had not exposed a probable main channel by which the ore constituents could be considered to have reached their position as found. There has been considerable recent development reported on this property and the erection of a furnace is in prospect for 1912.

In the northwestern part of Humboldt County, at the western base of the Kamma Mountains, a few miles southwest of Red Butte, west of the road to Rosebud, about 35 miles northwest of Humboldt House, and on the edge of the Black Rock Desert, is an interesting sulphur deposit associated with alunite and small quantities of cinnabar and gypsum.[2] The sulphur deposits are found in Tertiary, probably Miocene bedded tuffs, which have been cemented by deposition of quartz, chalcedony, and opal at the mines and which border on the west the rhyolites of the northern portion of the Kamma Mountains. The excavations are in loose, siliceous, harsh, pulverulent material resulting probably from the leaching of the rocks by hot waters. The sulphur deposits are thought to result from gases which were genetically related, but possibly not contemporaneous, with hot springs depositing silica. There has been a considerable output of sulphur from these mines but the associated cinnabar has apparently not yet proved of commercial value.

Lindgren[3] reports the occurrence of cinnabar at the interesting gold camp of National, in Humboldt County. The veins containing cinnabar are fissure fillings carrying quartz with drusy structure, stibnite, iron pyrite, gold and silver, the antimony and silver predominating, and the quicksilver content so far found being apparently of no commercial value. These veins lie mainly along rhyolite dikes, cutting flows of basalts and intrusions of rhyolite and andesites, are apparently dependent upon them, and are thought to be

[1] Ransome, F. L., op. cit., pp. 45–46.
[2] Adams, G. I., The Rabbit Hole sulphur mines, near Humboldt House, Nevada: Bull. U. S. Geol. Survey No. 225, 1904, pp. 497–500.
[3] Lindgren, Waldemar, The bonanza of National, Nevada: Jour. Washington Acad. Sci., vol. 2, No. 4, Feb. 19, 1912, pp. 107–108.

earlier in origin and somewhat different from the gold-silver-quartz vein whose shoot has furnished the extremely rich ore of the camp.

The gold prospect of Adamson & Turner, being developed on the west side of Winnemucca Mountain, about 5 miles northwest of Winnemucca, carries cinnabar in calcite associated with gold quartz veins.

*Nye County.*—In Nye County quicksilver deposits are found on both the east and the west sides of the Shoshone Range in the northern part of the county, at Belmont, near Death Valley in the Funeral Range, and on Bare Mountain, and new discoveries concerning which details are not yet available are reported north and south of Bare Mountain.

On the east slope of the Shoshone Range, near Bonita, prospects of cinnabar in rhyolite are reported, but details concerning them are lacking.

From 2 to 3 miles southeast of Ione, on the west side of the Shoshone Range, are the quicksilver properties of the Mercury and the Shoshone mining companies. These were visited by the writer in 1910, and a paper is in preparation describing them. The deposits lie in Shamrock and Sheep canyons, respectively, which are the first two canyons on the west side of the range immediately south of Ione Canyon, a low depression in the range through which passes the stage road from Austin and the Reese River valley near its head to Ione and the Ione Valley lying between the Shoshone and Paradise ranges to the west. The mountain ranges and valleys lie almost due north and south. The crest and the eastern slopes of this portion of the Shoshone Range are of rhyolite, and this rock is exposed part of the way down the western slope. Near the heads of the canyons are isolated exposures of upturned dark-blue crystalline limestone and a heavy-bedded quartzite conglomerate, both presumably Carboniferous, with strikes parallel to the trend of the range and of very narrow east-west development. Immediately west of these sediments and forming the western ridges and slopes down to the base of the range are heavy flows of basalts. South of Sheep Canyon lies a mass of granite into which the rhyolite is intrusive. The rhyolite itself is cut by a persistent north-south dark-colored rhyolite dike, and immediately west of this dike the quicksilver deposits are found in rhyolite and limestone near the heads of both canyons. The Mercury property is developed by a 100-foot shaft in highly altered and softened rhyolite and limestone at the rhyolite and limestone contact and by a crosscut from Shamrock Canyon southward to cut the shaft. The ore is cinnabar in fine veinlets in limestone, in limestone and rhyolite breccia, and in altered rhyolite. The relations indicate that the rhyolite has cut the limestone and quartzite and that north-south and northeast-southwest fractures have brecciated the contact, forming open spaces through which mineral solutions found their way. Vertical movement also has opened a fissure through which the extrusive north-south rhyolite dike found vent. The concentration of cinnabar is apparently mainly not far from the surface and in northeast-southwest cross-fracture zones between the rhyolite and limestone contact and the rhyolite dikes. Considerable ore, mainly of cinnabar in limestone, has been developed by the Mercury Mining Co., and a 25-ton Scott furnace was erected and began operations in the latter part of 1911. In Sheep Canyon colors of cinnabar are readily panned from the soil and rhyolite exposures on the northeast

slopes of the canyon and immediately west of the narrow north-south dark-colored rhyolite dike which is probably the continuation southward of the dike in Shamrock Canyon. The main concentration of ore so far developed, however, is along a nearly east-west fracture zone in rhyolite, parallel and adjacent to the rhyolite and granite contact along which some faulting is thought to have occurred. The rhyolite is in part silicified and in part apparently leached and porous, and in both states is impregnated with cinnabar. Shallow shafts and crosscuts of the Shoshone Mining Co. have exposed considerable ore and a retort plant erected lower down the canyon has treated the richer ore and produced considerable quicksilver.

In the old mining district of Belmont, in Nye County, southeast of Ione, cinnabar was reported to Becker [1] as occurring in rich seams of nearly pure mineral in the Barcelona silver mine, following along the argentiferous vein. No further details appear to be had.

On the property of the Bullfrog Cliff and adjoining the Death Valley claims, in the Funeral Range bordering Death Valley, cinnabar was identified in considerable quantity impregnating a 12-foot ledge of milling ore, according to press reports.[2]

On the northeast slopes of Bare Mountain, in the Flourine mining district, are some new quicksilver prospects, specimens from which show beautiful ores of milky and resin opals richly colored by cinnabar. The country rock is limestone according to Turner,[3] who has kindly supplied specimens and notes. According to Ball,[4] who mapped and described this portion of Nevada in reconnaissance, this limestone is correlated with the Pogonip limestone, which is at the base of the Ordovician. Rhyolite and basalt flows of Tertiary age form the north end of the Bare Mountain hills, and the limestone is cut by northeast-southwest rhyolite or porphyry dikes. The prospect of J. B. Kiernan has been opened by a shaft and several crosscuts, and the deposit appears to be along a north-south line. Twelve tons of ore from the surface are reported to have averaged over 20 per cent of metal, and a shipment of ore has recently been made to California for a trial run. The general sampling of a mass of pulverulent decomposed material from the workings described as "yellowish quartz sand" (possibly caused by loss of water by baking of the opaline mass) was reported to show a content of 0.8 per cent of quicksilver. Three other quicksilver prospects are being developed in the vicinity, a fourth lies 35 miles northeast from Springdale, and the occurrence of cinnabar is also reported on the south slopes of Bare Mountain, about 13 miles from Beatty. Details relative to these five last-named occurrences are lacking.

Cinnabar is also found, as a rare occurrence, coating pyrite or marcasite, in the West End mine at Tonopah.[5]

*Washoe County.*—In Washoe County are the well-known and frequently described Steamboat Springs, in which deposition of quicksilver with siliceous sinter by ascending hot waters is still going on.[6] The only deposit of cinnabar of apparent commercial

[1] Becker, G. F., op. cit., p. 385.
[2] Denver (Colorado) Times, Mar. 10, 1900.
[3] Turner, A. A., communication to the writer, Mar. 28, 1912.
[4] Ball, S. H., A geologic reconnaissance of southwestern Nevada and eastern California: Bull. U. S. Geol. Survey No. 308, 1907, p. 154.
[5] Burgess, J. A., Halogen salts of silver and associated minerals at Tonopah, Nev.: Econ. Geology, vol. 6, 1911, p. 21.
[6] Becker, G. F., op. cit., pp. 331–353.

value, however, was not found at the present springs, but in an area of decomposed granite some distance away. There were at one time some workings, now inaccessible, and a furnace, which has been credited with an output the details of which seem never to have been published.

## OREGON.

There was no output of quicksilver reported from Oregon in 1911, and the condition of the industry was quiet notwithstanding good prices and markets for the metal. There was, however, some prospect of renewed activity in 1912.

According to best available information the output of quicksilver in Oregon began in 1882. The production to date by years can not be given without disclosing individual figures for some years, but the total recorded output from 1882 to the end of 1912 has been 1,327 flasks, valued at $57,869.

Quicksilver has been reported from a larger number of localities in Oregon than is generally known, and although many of these deposits are apparently of little commercial importance the value of others is not yet disproved, and for the benefit of prospectors, geologists, and others the reported occurrences are summarized below.

*Baker County.*—In Baker County, in northeastern Oregon, in the gold belt of the Blue Mountains, the occurrence of cinnabar in the Sumpter and the Cracker Creek districts is noted by Lindgren.[1] The Columbia mine, on Fruit Creek about 8 miles north of Sumpter, contains gold-quartz veins in black Paleozoic argillite, carrying native gold, native copper, pyrite, arsenopyrite, zinc blende, pyrargyrite, cinnabar, schwatzite (the mercurial tetrahedrite), antimonite, chalcopyrite, stibnite, and a telluride. There has been no production of quicksilver from this source so far as known, nor is the cinnabar thought to be in commercial quantity here.

*Crook County.*—At Howard, near Prineville, in Crook County, central Oregon, are the Almaden cinnabar deposits, which have contributed to the output of metal in the State, but of which details as to occurrence are lacking. There was no output of quicksilver from this county in 1911.

*Douglas County.*—Near Elkhead, in Douglas County (which with Coos, Curry, Jackson, and Josephine counties, constitutes the metallogenetic province of southwestern Oregon, a continuation northward of the California mineral belt), is the Elkhead mine, reported to contain an extensive deposit of ore.[2] A furnace was in operation here several years ago. Float cinnabar has also been reported from Cow Creek, in Douglas County, and a deposit of cinnabar was being prospected in 1903 on the South Umpqua.[3] Considerable development work has been reported to the Survey from the Red Cloud quicksilver property, near Drew. There has been no output of metal so far as known, but further development was in prospect for 1912. The Bonanza mine, 9 miles east of Oakland, was a producer at one time. Two cinnabar occurrences in Tertiary sandstone have been noted by Diller in this vicinity.[4]

---

[1] Lindgren, Waldemar, The gold belt of the Blue Mountains of Oregon: Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 2, 1901, p. 664.

[2] Stafford, O. F., Mineral resources and mineral industries of Oregon: Bull. Univ. Oregon, No. 4, vol. 1, new ser., Eugene, Oreg., May, 1904, p. 99.

[3] Stafford, O. F., op. cit., p. 99.

[4] Diller, J. S., Roseburg folio (No. 49), Geol. Atlas U. S., U. S. Geol. Survey, 1898.

*Grant County.*—In the Red Boy gold mine in Granite district cinnabar occurs in quartz veins carrying gold and silver and minor quantities of pyrite, chalcopyrite, and arsenopyrite.[1] The country rock is the black Paleozoic argillite of the gold belt of the Blue Mountains in which this district lies. Porphyry dikes are encountered transverse to the veins. At Susanville, in this county, in the gold placers of Elk Creek, cinnabar in rounded masses up to 3 or 4 inches in diameter, intergrown with normal vein quartz, is of common occurrence, according to Lindgren.[2]

*Jackson County.*—In Jackson County, according to Stafford,[3] work has been done upon the Stanley quicksilver prospect, near Brownsboro, and at a point 3 miles south of Ashland some development of cinnabar veins has been made, resulting in a small production of metal for local use. In the Meadows district the Rogue River quicksilver claims have been developed by a shaft, and in the same district another shaft has been sunk on the Reed & Fletcher cinnabar deposit; and the Mayfield property is also reported to show a considerable supply of ore carrying 1 per cent of metal.

*Josephine County.*—In Josephine County, according to Stafford,[4] good specimens of float cinnabar have come from Pickett Creek. According to Kay[5] a small prospect of cinnabar has also been found on Palmer Creek, a branch of Applegate River, and considerable float is found in the stream gravels.

*Lane County.*—In Lane County, near Black Butte, on the northern spur of the Calapooya Mountains, lie the quicksilver claims of the Black Butte Quicksilver Mining Co., upon which has been done the most extensive work in the State. Although this mine has not been operated for the last two years and its total output reported to the Survey to date has not been large, it is equipped with a 50-ton modified Scott furnace and many other external improvements and is developed by over 12,000 feet of underground workings to a vertical depth of 1,500 feet.[6] The property was visited by the late S. F. Emmons, of the United States Geological Survey, and from his unpublished notes, written some years before his death and kindly given the writer, the following extracts are taken:

*Black Butte mercury mine.*—This mine is situated in Lane County, Oreg., about 2 miles north of the Douglas County line. The Black Butte, from which it derives its name, is part of a northern outlier of the Calapooya Mountains, lying at the head of West Fork of Willamette River, about 16 miles south of Cottage Grove station on the Southern Pacific Railroad. The summit is about 2,700 feet above sea level and has extremely steep slopes, making angles of 32° to 35°, which are covered with the dense growth of coniferous forest (with trees of 200 feet in height) common to the moist belt of western Oregon.

Owing to the forest covering and dense undergrowth rock outcrops are not common, and where found the rocks are generally very much decomposed. Exceptions to his rule are found in the actual stream beds where the softer part of the rocks have been worn away.

In his hurried visit the writer could, therefore, only determine in a general way that the prevailing rock of the region consists of an andesite and andesitic breccias traversed here and there by dikes of an older darker colored, more basic rock which, when seen, was so decomposed that its actual character could not be accurately determined, but it was thought to be of basaltic nature.

---

[1] Lindgren, Waldemar, op. cit., pp. 681–683.
[2] Idem, p. 708.
[3] Stafford, O. F., op. cit., pp. 98–99.
[4] Idem, p. 99.
[5] Diller, J. S., and Kay, G. F., Mineral resources of the Grants Pass quadrangle and bordering districts, Oregon: Bull. U. S. Geol. Survey No. 380, 1909, p. 79.
[6] Stafford, O. F., op. cit., pp. 99–100.

In the neighborhood of the mine, decomposition and alteration of the rock, due apparently to solfataric action, takes many forms. Kaolinization has evidently been very active. Sometimes white specks and thin stringlike veins of koalin run through it; again large portions become solid white, claylike masses. At other times the alteration produces dark-colored, semivitreous forms. On slickensided surfaces there are often thin seams of semitranslucent greasy material that cuts with the nail, which suggests serpentine, or may be on the order of decomposition products common to mineralized regions and known to the miners as Chinese talc. The few surface outcrops of the deposit that could be seen are on the north side of the butte not far from its summit. They indicate a strike of N. 67° E. with a dip of about 60° NE.

*Development.*—The mine is opened by crosscut tunnels running in on the north side of the hill, a system rendered advantageous by its steep slopes. Of these, the upper is about 200 feet below the outcrop, the second at 400 feet, and a third at 800 feet. As yet, only the workings of the two upper tunnels are connected by winzes with the surface. Another tunnel has been started some 1,200 to 1,500 feet below the surface outcrops, but has not yet reached the ore-bearing zone. On a shoulder at the base of the steeper slope are situated the reduction works erected by an earlier manager of the mine. The present manager, Mr. W. B. Dennis, having extended the underground workings so as to satisfy himself of the ore available, is now experimenting with a view of developing a process by which he can reduce to a profit lower grade ore than has hitherto proved profitable.

*Ore deposit.*—The ore is fine-grained cinnabar which impregnates the country rock along and in the neighborhood of fracture or fault planes and is generally accompanied by fine-grained pyrite. There is one strong fracture zone forming sometimes a single striated plane which forms the footwall, sometimes a double fracture plane, and in places there are several intersecting planes. The hanging wall is generally of breccia, though it passes in many places into solid andesite with no dividing line. Most of the ore occurs as an impregnation of the breccia or of the bleached fine-grained andesite in the footwall country. Along the fault plane is generally a one-half-inch seam of pyrite or limonite with relatively rich ore for a few inches on either side of it. In the breccia the ore forms narrow seams in the cement. In the solid rock it occurs along joint planes or as minute specks irregularly distributed throughout the mass. It is generally very low grade, one-tenth of 1 per cent of mercury being considered an average ore.

In the upper levels the pyrite is all oxidized and the rocks are thereby stained red, but the cinnabar does not seem to be affected. Only in the exceptionally rich part on the 400-foot level is the mercury found in the native state. The waters issuing from the mines carry abundant red oxide of iron in suspension, and at one point on the 800-foot level a large flat cave was found lined with a stalactitic deposit of limonite, which, however, carried no mercury.

The existence of a large amount of such low-grade ore has been actually proved and the developments render it probable that still more ore may be found, but the reduction of the general mass at a profit is a problem that still remains to be solved.

*Tillamook and Yamhill counties.*—In Tillamook and Yamhill counties, in the northwestern portion of Oregon, cinnabar deposits have been reported to Stafford,[1] but all details as to their occurrences and exact locations appear to be lacking.

## TEXAS.

Figures for the output of quicksilver in Texas in 1911 have been combined with those of Nevada in order to conceal individual production. In 1910 the output was 3,320 flasks of metal, valued at $154,413, from the treatment of 8,211 tons of ore.

The following table shows the quicksilver production of Texas from 1899 to the end of 1910:

*Production of quicksilver in Texas, 1899–1910, in flasks.*[2]

| | | | |
|---|---|---|---|
| 1899 | 1,000 | 1906 | 4,761 |
| 1900 | 1,800 | 1907 | 3,686 |
| 1901 | 2,932 | 1908 | 2,382 |
| 1902 | 5,319 | 1909 | 4,188 |
| 1903 | 5,029 | 1910 | 3,320 |
| 1904 | 5,336 | | |
| 1905 | 4,723 | Total | 44,476 |

[1] Stafford, O. F., op. cit., p. 98.

[2] Flasks, 76½ pounds net; 75 pounds since June 1, 1904.

The value of the total output, estimated at the average domestic San Francisco prices for each year, is $1,916,400.

*Brewster County.*—The quicksilver deposits so far discovered in Texas are in Brewster County, on the Mexican border, and in the semiarid trans-Pecos country. The deposits that have been productive are all within a few miles of the Rio Grande, in the Terlingua district, in three subdistricts lying in an east-west line with the Chisos in the center, the Terlingua proper 5 miles to the west, and the Study Butte 5 miles to the east. Field work on the district has been begun by the writer and a paper describing it is in preparation. A summary of the geology was given in the chapter on quicksilver for 1907.[1] The district has been frequently visited and briefly described and a fairly complete list of references to the literature was given in this chapter for 1910.[2] The general descriptive papers of Hill, Phillips, and Turner will be found particularly useful to one investigating the region.[3]

The Terlingua district proper, which lies west of a notable northwest-southeast fault, in a rugged area of uplift of Lower Cretaceous limestones and shales, has been the source of the larger part of the output of the region, but there was no output from this source in 1911. In California Hill the Marfa and Mariposa workings, in vertical northeast-southwest fissure veins in limestones, have been the most productive. Immediately east of the main fault of the area are the Chisos workings in vertical veins in thin-bedded Upper Cretaceous limestones and shales. The development work now extends through these sediments into the underlying massive limestone which forms the upper member of the Lower Cretaceous. The Chisos mine and furnace have been steadily productive since the beginning of operations, but for the last two years have been handicapped in operation by the Mexican disturbances, the influence of which invariably extends across the border into the Big Bend country of Texas, which is remote from the railway, thinly populated, and exposed to marauding forays. The Texas-Almaden and the Big Bend mines to the east of the Chisos are in the igneous intrusives of Study Butte and were both idle in 1911. All the principal properties of the Terlingua district are well equipped with modern Scott furnaces.

To the southeast of Terlingua on the north spur of Mariscal Mountain, to the northeast on Christmas Mountain, and at various other points in the general region, cinnabar has been found, but developments have not been extensive. Recent reports indicate that new interests may enter the field and develop their prospects.

## UTAH.

There has been no production of quicksilver in Utah since 1907, when output of this metal as a by-product ceased at the properties of the Sacramento Gold Mining Co., in the Mercur or Camp Floyd districts in Tooele County. This company had been producing

[1] McCaskey, H. D., Quicksilver: Mineral Resources U. S. for 1907, U. S. Geol. Survey, pt. 1, 1908, pp. 681–682.

[2] McCaskey, H. D., Quicksilver: Mineral Resources U. S. for 1910, U. S. Geol. Survey, pt. 1, 1911, pp. 705–710.

[3] Hill, B. F., The Terlingua quicksilver deposits, Brewster County, Tex.: Bull. Texas Univ. Mineral Survey, No. 4, 1902.

Phillips, W. B., The quicksilver deposits of Brewster County, Tex.: Econ. Geology, vol. 1, 1905, pp. 155–162.

Turner, H. W., The Terlingua quicksilver deposits, Texas: Econ. Geology, vol. 1, 1905, pp. 265–281.

quicksilver during the period from 1903 to 1907, inclusive, prior to which there had been no reported output of the metal since the Richmond Quicksilver Co. ceased operations at the Lucky Boy mine in Marysvale, Piute County, after a short run during the period 1881–1887. These two operators are the only producers in Utah of which records are at hand.

The total output of quicksilver in Utah during its productive periods from 1881 to 1887 and from 1903 to 1907, inclusive, was 3,551 flasks, valued at $139,600. Of this production 3,338 flasks, valued at $131,292, is to be credited to the Mercur district and 213 flasks, valued at $8,308, is estimated to have been the output of the Marysvale district. The entire output of the State has been from retorts.

*Kane County.*—According to newspaper reports, both cinnabar and native quicksilver are found in the gravels of Paria and Colorado rivers near their junction.

*Piute County.*—The Lucky Boy quicksilver propsect was briefly described by Prof. J. E. Clayton, president of the Salt Lake Mining Institute, in a letter to Prof. G. J. Brush, of the Sheffield Scientific School, dated October 6, 1884,[1] whose note as to the occurrence of tiemannite is as follows:

> The mine is situated about 5 miles southwest of Marysvale, 200 miles south of Salt Lake City. It is on the east face of a mountain slope and near a profound fault extending north and south. To the east are eruptive rocks, including porphyry and trachyte. Underlying the ore beds to the west is quartzite of unknown thickness, over this about 400 feet of gray limestone, and in contact between these the Deertrail vein is situated, carrying gold, silver, lead, and a little copper. In the upper portions of the limestone the selenide of mercury is found in a bed of shaly limestone 15 to 20 feet thick. The vein has been traced north and south about 100 feet along the outcrop and dips into the mountain at an angle of about 15° below the horizon. The ore occurs in masses intermixed with the shaly limestone, crystals being very rare. The accompanying minerals are barite, oxide of manganese, quartz, and calcite. The ore bed is overlain by a yellowish sandy lime shale carrying sub-Carboniferous fossils.

The occurrence was visited by the writer in 1910, and the deposit was found to lie on the steep fault scarp of the east side of the north-south trending Tushar Range, the first of the Basin ranges west of the great plateau province, from which it is separated by Sevier Valley. The range exposes southwest of Marysvale from 1,600 to 2,000 feet of alternating quartzites and limestones, and is capped by igneous flows and breccias, which Butler has provisionally classed as dacite,[2] and by overlying rhyolite. The workings of the Lucky Boy mine show a bowl-shaped open cut, just north of Cottonwood Canyon, about 100 feet in diameter and 60 feet deep, a drift to the west about 80 feet into the mountain following the gently dipping bedding planes, a tortuous winze from the face of the drift turning back and coming out on the mountain side about 50 feet below the open cut, and a shaft at the bottom of the open cut, now filled with broken rock and reported to have been sunk about 40 feet on a north-south narrow nearly vertical vein, carrying barite and some cinnabar. The cinnabar ore, it seems, was of low grade, and the commercial ore was mainly of onofrite and to a smaller degree of tiemannite, the sulpho-selenide and the selenide of mercury, which were found in a deposit from 2 to 8 inches thick, following the bedding planes and impreg-

[1] Penfield, S. L., Crystallized tiemannite and metacinnabarite: Am. Jour. Sci., 3d ser., vol. 29, 1885, p. 454.
[2] Butler, B. S., and Gale, H. S., Alunite, a newly discovered deposit near Marysvale, Utah: Bull. U. S. Geol. Survey No. 511, 1912, p. 14.

nating the impure dark-gray limestone. The presence of tiemannite was reported also in the barite vein, and the fissure here may have been the channel for the ore solutions. The intersection of this fissure with the bedding vein would be about where the open cut now is, and indeed much of the original deposit has probably been eroded away. The deposit was evidently superficial, for the life of the operations was short, the total output was small, and it is now difficult to find even samples of ore in the workings. The occurrence is of especial interest as being the only deposit of the selenides of mercury in the country ever worked on a commercial scale, however small. The reduction was by two retorts operated in Cottonwood Canyon to the south of the mine. In the Deertrail gold mine, several hundred feet vertically below the Lucky Boy, and along the gently westward-dipping bedding planes at the quartzite and limestone boundary, cinnabar with pyrite was reported in a small lens. The deposition of quicksilver minerals in both properties may have been due to solutions arising through the same vertical north-south fissures thought to extend parallel to the great Sevier fault, and may have been localized by transverse fissures similar to those known elsewhere in the district.

*Tooele County.*—In the Mercur or Camp Floyd district quicksilver has been produced as a by-product by the Sacramento Gold Mining Co., although there has been no output since 1907. Boutwell has briefly described the occurrence.[1]

> The ore is earthy cinnabar with a siliceous gangue and yields 6 per cent on an average and 80 per cent in picked samples. It occurs in bands in an altered cherty limestone adjacent to a dike and to a fracture zone. In general the portion of this limestone which bears quicksilver constitutes a lenticular shoot measuring about 10 feet in thickness, 50 feet along the strike, and 140 feet on the dip. This lens is coincident with the bedding of the limestone along the middle and major portion of its dip, but at its upper edge it bends and cuts abruptly across the bedding; while at its lower edge, on approaching the dike and fracture on its dip, it drops sharply down across the bedding, pinching out at both its upper and lower terminations to thin edges. This main shoot of good ore is now approaching exhaustion, and though other bodies have been found on the property, they are of much lower grade. The ore is treated on the property in six retorts, each taking four pans, which afford a total capacity of 20,000 tons.

According to Raymond,[2] cinnabar deposits had been discovered in the district in 1873, and an incline 50 feet deep had been sunk on ore carrying 4 per cent of quicksilver on the Jenny Lind claim and a 20-foot incline on similar ore had been sunk on the New Idria, on the same vein as the Jenny Lind. This was probably the outcrop of the Gold Ledge of the camp, which carries also gold, realgar, pyrite, barite, calcite, and quartz. The barite is known to contain both gold and cinnabar. The cinnabar has been found mainly in earthy form, but is also found in crystalline, and is evidently thought by Spurr,[3] who has described the district, to have been deposited as the former by pneumatogenetic and as the latter by hydatogenetic agencies. The occurrence of quicksilver in the ores of the Mercur district has also been discussed by Hills,[4] who mentions also the presence of orpiment and rhodochrosite among the ores.

---

[1] Boutwell, J. M., Quicksilver: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, p. 494.

[2] Raymond, R. W., Statistics of mines and mining in the States and Territories west of the Rocky Mountains, Sixth Ann. Rept., 1874, p. 277.

[3] Spurr, J. E., Economic geology of the Mercur mining district, Utah: Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1896, p. 451.

[4] Hills, R. C., Ore deposits of the Camp Floyd district, Tooele County, Utah: Proc. Colorado Sci. Soc. vol. 5, 1898, pp. 54–65.

Considerable bodies of cinnabar were found in the Mercur, Geyser, and Marion mines, but the production was entirely from the Sacramento mines.

## WASHINGTON.

There has been no reported production of quicksilver from Washington, but the occurrence of cinnabar is known in the State, and during 1911 some activity was reported in prospecting there for that metal.

*Chelan County.*—Discoveries of cinnabar in 1911 near Orondo, Chelan County, were reported to the writer, and samples received show crystalline cinnabar associated with quartz. One lode is reported to be about 12 feet wide, about 1 foot of which shows liberal distribution of cinnabar, and the remainder of which is of low grade. Further details of the occurrence and developments are lacking, but Calkins [1] has identified rocks from the vicinity as granophyre, diorite, and diabase. The latter carries a little interstitial quartz, and one of the ore specimens sent the writer from Orondo is a siliceous altered rock impregnated with cinnabar.

*Kittitas County.*—In Kittitas County there have been prospecting and development of quicksilver deposits, but no production has been reported and details of occurrences are not at hand. Smith [2] has reported cinnabar at a few points at the head of Middle Fork of Teanaway River. In a prospect on the western edge of the Mount Stuart quadrangle the cinnabar is found along a joint plane of the altered rocks of the Peshastin formation, which includes black slates, bands of chert, thin beds of grit, and lenses of limestone. According to Smith, the richness of the ore is evident, but the fact that such bands of cinnabar are very thin may prevent the deposit from being of economic importance.

## ALASKA.

The occurrence in Alaska of cinnabar in gravels and in one locality at least in place has been known for many years.[3] On the lower Kuskokwim, about 5 miles below Kolmakof, in a cliff on the right side of the river, a vein of cinnabar was found that was reported by its discoverer to be an impregnation of arkose and other sediments, in a vertical zone 1 or 2 feet wide, often irregular and pinching out. Ore from this place was shipped to the United States for treatment, but the shipment did not pay expenses. The locality, according to Spurr, is one where stratified shales are cut by acidic dikes. On Daniels Creek, about 60 miles east of Nome, on Seward Peninsula, according to Moffit,[4] cinnabar occurs in the creek gravels and is caught in sluice boxes with the gold. Although the bedrock source of this cinnabar has not been found, it evidently lies close at hand in a contact zone of schist and limestone.[5]

During the writing of this report information has been received of a new discovery of cinnabar ore between Kuskowim and Yukon rivers. Several claims have been recorded by the discoverer, and some of the ore is said to be rich. No other details are at hand.

---

[1] Smith, G. O., and Calkins, F. C., A geological reconnaissance across the Cascade Range near the forty-ninth parallel: Bull. U. S. Geol. Survey No. 235, 1904, pp. 74, 77, and 79.

[2] Smith, G. O., Mount Stuart folio (No. 106), Geol. Atlas U. S., U. S. Geol. Survey, 1904, p. 9.

[3] Spurr, J. E., A reconnaissance in southwestern Alaska: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, p. 261.

[4] Moffit, F. H., Gold mining on Seward Peninsula: Bull. U. S. Geol. Survey No. 284, 1906, p. 139.

[5] Brooks, A. H., Mineral resources of Alaska in 1910: Bull. U. S. Geol. Survey No. 480, 1911, p. 93.

## WORLD'S PRODUCTION.

The following table gives the world's production of quicksilver, in metric tons of 2,204.6 pounds, for the years 1903–1910. For foreign countries the quantities given are partly from the corrected figures of the Seventeenth Annual Issue of Comparative Statistics, compiled by the Metallgesellschaft, Metallurgischen Gesellschaft A. G., and the Berg- und Metallbank Aktiengesellschaft, of Frankfort on the Main, Germany; for the United States the figures are those of the United States Geological Survey; and for Spain for 1907 and 1908 they are those of United States Consular Agent A. E. Carleton, published in the Daily Consular and Trade Report No. 3585.

*World's production of quicksilver, 1903–1910, in metric tons.*

| Country. | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | 1910 |
|---|---|---|---|---|---|---|---|---|
| United States | 1,237 | 1,188 | 1,036 | 892 | 734 | 672 | 717 | 701 |
| Austria-Hungary | 575 | 550 | 570 | 577 | 610 | 630 | 609 | 694 |
| Italy | 313 | 357 | 369 | 418 | 423 | 680 | 771 | [a] 800 |
| Russia | 362 | 332 | 318 | 210 | 130 | 49 | 7 | 4 |
| Spain | 968 | 1,130 | 853 | 1,567 | 1,210 | 1,065 | [a] 1,000 | [a] 1,000 |
| Mexico | 188 | [a] 190 | [a] 190 | [a] 200 | [a] 200 | [a] 200 | [a] 200 | [a] 200 |
| Total | 3,643 | 3,747 | 3,336 | 3,864 | 3,307 | 3,296 | 3,304 | 3,399 |

[a] Partly estimated.

## FOREIGN MINES, MINING CONDITIONS, AND MARKETS.

At the request of the United States Geological Survey the Consular Service of the State Department is obtaining information on (a) mines and reduction works, (b) production, (c) imports and exports, (d) consumption and uses, (e) prices, and (f) descriptive data, of quicksilver in the respective consular districts abroad. The inquiry is not yet complete, but it is hoped to summarize the data in the Survey report on quicksilver for 1912. In the meantime the Bureau of Manufactures of the Department of Commerce and Labor have been supplied with copies of consular reports already received on the subject and are publishing some extracts in their Daily Consular and Trade Reports, some of which have been republished, though not always with credit given, by the daily and technical press. That bureau will also be glad to loan manuscript copies of the consular reports for consultation to responsible applicants who may be interested in information on particular foreign districts.

For the courtesy of the Department of State and the Bureau of the Consular Service and for the zeal of the American consuls abroad who have furnished information hearty thanks are given by the Survey.

## IMPORT TARIFF ON QUICKSILVER.

The import tariff on quicksilver imposed by the Payne-Aldrich tariff bill (H. R. 1438) approved August 5, 1909, is 7 cents per pound, or $5.25 per flask of 75 pounds net, or the same rate that had prevailed for several years previous to the passage of the act. Some question having arisen as to the effect of revision of this rate a review of the domestic situation may be of value.

It is generally understood that the bulk of the foreign output of quicksilver and the London price are controlled by the Rothschilds, and also that this firm practically controls the market outside the United States. The domestic industry is understood to be free from control by any trust. It is also understood that cost of production in the foreign mines is lower than in the United States, and it is known that the average grade of ore worked in the Almaden mines of Spain, the largest producers—and reported to be controlled by the Rothschilds—is several hundred per cent higher than the average grade (given in a preceding table) treated in the United States. As shown by the tables of London and domestic prices, the London price is uniformly lower than that at New York and also lower than that at San Francisco, the main source of domestic supply. The difference in domestic prices at San Francisco and New York is mainly the cost of shipment. The difference between New York and London prices is mainly due to the tariff.

The annual domestic consumption appears to have been of recent years from 18,000 to 21,000 flasks, or about equal to the domestic production. A number of domestic mines with established plants have closed down, mainly from exhaustion of ore supply, and as it is not to be expected from present knowledge that the remaining older established mines and plants will greatly increase their output, prospecting and development of new supplies must be depended upon to maintain the domestic output. Such activities are necessarily more costly than production from established properties and are dependent upon favorable metal prices for encouragement. Indeed it is commonly understood that certain California mines of small output are only operated during periods when prices are good.

It does not seem probable that the larger operators, on the one hand, can produce metal at a much lower cost, treat ore of much lower grade at a profit, or develop considerable quantities on their properties of higher grade ore than at the present time. The larger number of smaller producers, on the other hand, have in sight smaller quantities of ore, and with smaller plants and less extensive equipment are presumably producing at a higher cost.

## IMPORTS AND EXPORTS.[1]

Owing to decrease of domestic stocks and higher prices in 1911 the imports of quicksilver were the heaviest in many years, increasing from 667 pounds, valued at $381, in 1910 to 471,944 pounds, or 6,293 flasks, valued at $251,386, in 1911. Correspondingly the exports decreased from 1,923 flasks, valued at $91,007, in 1910 to 291 flasks, valued at $13,995, in 1911—the smallest export in many years.

The imports were almost wholly into New York, and included 4,463 flasks from England, 1,203 flasks from Mexico, and 600 flasks from Italy.

[1] For statistics of imports and exports acknowledgment is made to the Bureau of Statistics of the Department of Commerce and Labor, which has kindly supplied data especially requested for this report.

The following tables show the quantity and value of quicksilver imported and exported for the period from 1905 to 1911, inclusive:

*Quicksilver imported and entered for consumption in the United States, 1905–1911, in pounds.*

| Year. | Quantity. | Value. |
|---|---|---|
| 1905 | 2,690 | $1,710 |
| 1906 | 84 | 50 |
| 1907 | 16,567 | 6,719 |
| 1908 | 15,113 | 8,216 |
| 1909 | 15,968 | 8,203 |
| 1910 | 667 | 381 |
| 1911 | 471,944 | 251,386 |

*Exports of quicksilver from the United States, 1905–1911, in flasks of 75 pounds.*

| Year. | Quantity. | Value. |
|---|---|---|
| 1905 | 13,534 | $489,756 |
| 1906 | 6,456 | 243,914 |
| 1907 | 5,132 | 192,094 |
| 1908 | 2,996 | 124,960 |
| 1909 | 6,802 | 266,243 |
| 1910 | 1,923 | 91,077 |
| 1911 | 291 | 13,995 |

As the foreign market for domestic production is of interest to those engaged in the industry, the following table has been prepared for the purpose of presenting in detail the distribution of exports from the United States during 1909, 1910, and 1911:

*Exports of domestic quicksilver from the United States in 1909, 1910, and 1911, by countries, in pounds.*

| Country. | 1909 | | 1910 | | 1911 | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Canada | 421,136 | $214,037 | 81,745 | $52,590 | 9,585 | $6,318 |
| Costa Rica | | | 2,475 | 1,585 | 2,550 | 1,594 |
| Honduras | 144 | 95 | 1,194 | 763 | 229 | 143 |
| Nicaragua | 4,704 | 2,839 | 1,979 | 1,212 | 1,436 | 905 |
| Panama | 118 | 70 | 285 | 175 | | |
| Salvador | 151 | 90 | 375 | 220 | 300 | 181 |
| Mexico | 81,035 | 47,446 | 48,678 | 29,736 | 5,285 | 3,262 |
| Newfoundland | | | | | 75 | 48 |
| Cuba | 165 | 90 | | | | |
| Santo Domingo | 5 | 4 | 20 | 17 | 95 | 63 |
| Brazil | | | 1,081 | 757 | 54 | 36 |
| Colombia | 863 | 495 | 2,718 | 1,630 | 1,662 | 1,088 |
| Ecuador | | | | | 45 | 36 |
| Dutch Guiana | | | 95 | 63 | | |
| Venezuela | 165 | 99 | 26 | 18 | 75 | 45 |
| Chosen (Korea) | 1,054 | 617 | 1,950 | 1,314 | | |
| Philippines | 601 | 361 | 1,616 | 997 | 450 | 276 |
| Total | 510,141 | 266,243 | 144,237 | 91,077 | 21,841 | 13,995 |

In the following table are given the exports from San Francisco in 1909, 1910, and 1911:

*Exports of domestic quicksilver from San Francisco in 1909, 1910, and 1911, by countries, in flasks of 75 pounds.*

| Country. | 1909 | | 1910 | | 1911 | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| Canada | 18 | $839 | 34 | $1,559 | 10 | $440 |
| Costa Rica | | | 32 | 1,530 | 30 | 1,390 |
| Honduras | | | 15 | 720 | 1 | 50 |
| Nicaragua | 2 | 90 | 5 | 250 | 8 | 357 |
| Salvador | 2 | 90 | 5 | 220 | 4 | 181 |
| Mexico | 928 | 41,134 | 517 | 24,184 | 60 | 2,783 |
| Colombia | | | 1 | 51 | 5 | 263 |
| Chosen (Korea) | 14 | 617 | 26 | 1,314 | | |
| Philippines | 8 | 361 | 13 | 605 | 2 | 95 |
| Total | 972 | 43,131 | 648 | 30,433 | 120 | 5,559 |

## PRICES.

Prices of quicksilver generally maintained in 1911 the improvement begun in 1907, as is shown by the following table:

*Average yearly prices of quicksilver in the United States, and highest and lowest London quotations, from 1907 to 1911, inclusive.*

| Year. | San Francisco (flask of 75 pounds). | | New York (flask of 75 pounds). | London (bottle of 34.5 kilos). | |
|---|---|---|---|---|---|
| | Domestic. | Export. | | Highest. | Lowest. |
| | | | | £ s. d. | £ s. d. |
| 1907 | $39.60 | $38.17 | $41.50 | 8 5 0 | 6 15 0 |
| 1908 | 44.17 | 42.54 | 44.84 | 8 10 0 | 7 12 6 |
| 1909 | 45.45 | 43.45 | 46.30 | 9 17 6 | 7 19 0 |
| 1910 | 46.51 | 44.51 | 47.06 | 9 15 0 | 8 0 0 |
| 1911 | 46.01 | 43.62 | 46.54 | 10 0 0 | 7 10 0 |

## BIBLIOGRAPHY.

In the report on quicksilver for 1910 a fairly complete list of the references to the literature on quicksilver for the North American continent was given. Copies of that report are still available for distribution. The list there given should be supplemented (where not duplicated) by the references in the footnotes of the present report, and by the following, which will bring the bibliography up to the end of 1911.

Bancroft, Howland, Reconnaissance of the ore deposits of northern Yuma County, Arizona: Bull. U. S. Geol. Survey No. 451, 1911. Abstract: Jour. Washington Acad. Sci., vol. 1, No. 6, p. 184, October, 1911. Describes the topography, general geology, distribution, character, and relation of pre-Cambrian, Mesozoic, Tertiary, and Cretaceous igneous and volcanic rocks, the periods and character of mineralization, and the mineral deposits, gold, copper, quicksilver, etc.

Barriga, M. D., Mining in Mexico: Mining Journal, May 29, 1905.

Beck, R., and Weed, W. H., Nature of ore deposits, New York and London, 1905, pp. 350–360.

Booth, F. J., The reduction of quicksilver ore: Min. and Sci. Press, Nov. 10, 1906.

Brown, C. F., Oil-burning mercury retort furnace and condenser: Min. Reporter, April 18, 1907.

Brush, G. J., and Comstock, W. J., On American sulphoselenides of mercury, with analyses of onofrite from Utah: Am. Jour. Sci., 3d ser., vol. 21, 1881, pp. 312–316.
Mining and Scientific Press, Cinnabar in San Luis Obispo County, California. Nov. 12, 1904.
——— The Great Eastern quicksilver mine, Dec. 10, 1904.
——— Quicksilver in California. Jan. 1, 1910.
Mining and Engineering Review, Quicksilver production in California, Jan. 28, 1905.
Capilla, Alberto, Brevas anotaciones sobre la mina de mercuria "La Guadalupana," San Luis Potosí: Mem. y rev. Soc. cient. "Antonio Alzate," vol. 13, Nos. 9, 10.
Clarke, F. W., The data of geochemistry, 2d ed.: Bull. U. S. Geol. Survey No. 491, 1911; mercury, pp. 633–638.
Collins, H. F., Quicksilver mining in Guadalcazar: Trans. Inst. Min. and Met., London, vol. 4, p. 121.
Eddy, L. H., Quicksilver in California in 1910: Eng. and Min. Jour., vol. 91, 1911, p. 85.
Edwards, C. E., California quicksilver industry: Min. World, Feb. 24, 1906.
Fawcett, W., A quicksilver furnace: Am. Inventor, November, 1905.
Geary, J. W., A rotary furnace for roasting quicksilver ores: Min. and Sci. Press., Jan. 14, 1905.
——— Condensation of quicksilver vapors: California Jour. Tech., 1905; also Min, Reporter, Apr. 19, 1906.
Kemp, J. F., Ore deposits of the United States, 3d ed., 1900, p. 424–428.
Le Conte, Joseph, and Rising, W. B., The phenomena of metalliferous vein formation now in progress at Sulphur Bank, Cal.: Am. Jour. Sci., 3d ser., vol. 24, 1882, pp. 23–33.
Le Conte, Joseph, On mineral vein formation now in progress at Steamboat Springs compared with the same at Sulphur Bank: Am. Jour. Sci., 3d ser., vol. 25, 1883, pp. 424–428.
Lowell, F. H., Quicksilver for 1910: Min. and Sci. Press, vol. 102, 1911, p. 62.
McCaskey, H. D., Quicksilver: Mineral Resources U. S. for 1909, pt. 1, U. S. Geol. Survey, 1911, pp. 549–559.
——— Quicksilver: Mineral Resources U. S. for 1910, pt. 1, U. S. Geol. Survey. 1911, pp. 693–710.
Maltear, James, Quicksilver in Mexico: Trans. Inst. Min. and Met., London, vol. 4, pp. 69, 155.
Melville, W. H., Metacinnabarite from New Almaden, Cal.: Bull. U. S. Geol. Survey No. 78, 1891, pp. 80–83.
Miller, W. G., Notes on the Cobalt area: Eng. and Min. Jour., vol. 92, 1911, pp. 645–649. Notes discovery of mercury in Cobalt ores.
Mining and Scientific Press, Reduction of cinnabar at Sulphur Creek, California, May 27, 1905.
——— The quicksilver situation. May 28, 1910.
Mining and Engineering Review, Metallurgy of quicksilver, Aug. 30, 1905.
Mulholland, C. A., The treatment of low-grade cinnabar ores: Min. and Eng. World, Aug. 5, 1911, pp. 241–242. (Abstract from Australian Mining Standard of June 8, 1911.)
Pacific Miner, A mercury deposit in Oregon near the producing State: Mar. 1, 1905.
Pagliucci, F. D., The Huitzuco, Mexico, quicksilver deposits: Eng. and Min. Jour., Feb. 18, 1905.
Penfield, S. L., Crystallized tiemannite and metacinnabarite: Am. Jour. Sci., 3d ser., vol. 29, 1885, pp. 449–454.
Phillips, J. A., and Louis, H., A treatise on ore deposits, 2d ed., 1896, pp. 117, 135, 143, 747, 791.
Phillips, W. B., Prospects of the quicksilver industry in Texas: Min. World, Oct. 13, 1906.
——— The quicksilver industry in Texas: Eng. and Min. Jour., vol. 91, 1911, p. 85.
Ries, Heinrich, Economic geology with special reference to the United States, rev. ed., 1910, pp. 532–537.
Rolland, G., Les gîsements de mercure de Californie: Annales des mines, 1878.
Stovall, D. H., Quicksilver mining in Oregon: Min. World, Jan. 28, 1905.
——— Oregon's quicksilver mine: Los Angeles Min. Rev., Mar. 4, 1905.
——— Quicksilver extraction: Los Angeles Min. Jour., Aug. 12, 1905.
Udden, J. A., Structural relations of quicksilver deposits (Texas): Min. World, vol. 34, May 13, 1911, pp. 973–975.
Whitton, W. W., The determination of mercury in ores: California Tech. Jour., vol. 4, No. 1, September, 1904.

# BAUXITE AND ALUMINUM.

By W. C. Phalen.

## BAUXITE.

### PRODUCTION.

The production of bauxite in the United States in 1911 amounted to 155,618 long tons, valued at $750,649. Compared with the production in 1910 this represents an increase of 6,686 long tons, or more than 4 per cent, in quantity, and of $34,391, or very nearly 5 per cent, in value. The increases, though small, are normal and indicate a healthy condition in the bauxite industry and those industries dependent on it. The output of bauxite has settled down to the natural level of the demand for it, and the growth during succeeding years can hardly be expected to show the great gains which have characterized the history of the output of the ore at times during the past. The average price of the ore per long ton at the mines for the last three years has been—1909, $5.26; 1910, $4.81; 1911, $4.82.

The States which produced bauxite in 1911 were, as heretofore, Arkansas, Georgia, Alabama, and Tennessee. The new field in central Georgia now produces, as well as the old field in the northwestern part of the State. An account of the work going on in the recently discovered deposits of central Georgia is given in the following pages. As usual, Arkansas led in the production of bauxite, the output of the State showing a gain of 11 per cent as compared with 1910. There was a decline in the output of each of the other States producing.

The following table gives the production and value of bauxite from 1889 to 1911, inclusive:

*Production of bauxite in the United States, 1889–1911, by States, in long tons.*

| Year. | Georgia. | Alabama. | Arkansas. | Total. | Value. |
|---|---|---|---|---|---|
| 1889 | 728 | | | 728 | $2,366 |
| 1890 | 1,844 | | | 1,844 | 6,012 |
| 1891 | 3,301 | 292 | | 3,593 | 11,675 |
| 1892 | 5,110 | 5,408 | | 10,518 | 34,183 |
| 1893 | 2,415 | 6,764 | | 9,179 | 29,507 |
| 1894 | 2,050 | 9,016 | | 11,066 | 35,818 |
| 1895 | 3,756 | 13,313 | | 17,069 | 44,000 |
| 1896 | 7,313 | 11,051 | | 18,364 | 47,338 |
| 1897 | 7,507 | 13,083 | | 20,590 | 57,652 |
| 1898 | | | | 25,149 | 75,437 |
| 1899 | 15,736 | 14,499 | 5,045 | 35,280 | 125,598 |
| 1900 | 19,739 | | 3,445 | 23,184 | 89,676 |
| 1901 | 18,038 | | 867 | 18,905 | 79,914 |
| 1902 | 22,677 | | 4,645 | 27,322 | 120,366 |
| 1903 | 22,374 | | 25,713 | 48,087 | 171,306 |
| 1904 | 21,913 | | 25,748 | 47,661 | 235,704 |
| 1905 | 15,173 | | 32,956 | 48,129 | 240,292 |
| 1906 | 25,065 | | 50,267 | 75,332 | 368,311 |
| 1907 | | | | [a] 97,776 | 480,330 |
| 1908 | 14,464 | | [a] 37,703 | 52,167 | 263,968 |
| 1909 | 22,227 | | [a] 106,874 | 129,101 | 679,447 |
| 1910 | 33,096 | | [a] 115,836 | 148,932 | 716,258 |
| 1911 | 30,170 | | [a] 125,448 | 155,618 | 750,649 |

[a] Production of Tennessee included.

## CONSUMPTION.

The following table gives the annual production, imports, consumption, and value of bauxite in the United States during the last five years:

*Production, imports, and consumption of bauxite in United States, 1907–1911, in long tons.*

| Year. | Production. | | Imports. | | Consumption. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1907 | 97,776 | $480,330 | 25,066 | $93,208 | 122,842 | $573,538 |
| 1908 | 52,167 | 263,968 | 21,679 | 87,823 | 73,846 | 351,791 |
| 1909 | 129,101 | 679,447 | 18,688 | 83,956 | 147,789 | 763,403 |
| 1910 | 148,932 | 716,258 | 15,669 | 65,743 | 164,601 | 782,001 |
| 1911 | 155,618 | 750,649 | 43,222 | 164,301 | 198,840 | 914,950 |

## WORLD'S PRODUCTION.

The following table shows the world's production of bauxite from 1908 to 1910:

*World's production of bauxite, 1908–1910, in long tons.*

| Country. | 1908 | | 1909 | | 1910 | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| United States | 52,167 | $263,968 | 129,101 | $679,447 | 148,932 | $716,258 |
| France | 167,991 | 326,987 | 128,099 | 251,188 | (*b*) | (*b*) |
| United Kingdom | 11,716 | 14,671 | 9,500 | 11,679 | 3,792 | 4,292 |
| Italy | 6,890 | 12,160 | 3,881 | 7,610 | (*b*) | (*b*) |
| India | (*a*) | (*a*) | 32 | 58 | 66 | 122 |
| Total | 238,764 | 617,786 | 270,613 | 949,982 | ..... | ..... |

*a* Production of 32 long tons; value not available. *b* Statistics not available.

## NEW SOURCE OF ALUMINA.[1]

A study of the alunite deposits near Marysvale, Utah, and in othe parts of the Western States by the United States Geological Survey indicates that the mineral alunite may become at some future time an important source of alumina.

The mineral alunite is a hydrous sulphate of aluminum and potassium, having the formula $K_2O.3Al_2O_3.4SO_3.6H_2O$. In its pure condition it contains 11.4 per cent of potassa ($K_2O$), 37 per cent of alumina ($Al_2O_3$), 38.6 per cent of sulphuric anhydride ($SO_3$), and 13 per cent of water ($H_2O$). The theoretically pure mineral is of rare occurrence in nature, but the analyses of the mineral found near Marysvale, Utah, show that it approaches in composition that of the pure mineral.

Attention has recently been attracted to this mineral as a source of potash, but the experiments on it have shown that while sulphate of potassium may be obtained from it, it is not to be ignored as a source

[1] Bull. U. S. Geol. Survey No. 511, 1912.

of alumina. The experiments of W. T. Schaller in the laboratory of the United States Geological Survey—

showed that on igniting the powdered alunite all of the water and three-quarters of the sulphuric acid are volatilized. On leaching the residue with water the potassium sulphate is dissolved, leaving the insoluble aluminum oxide behind.

The average amount of potassium sulphate leached from the ignited mineral powder is 17.9 per cent of the original material used. As the coarsely crystallized alunite was found to contain 19.4 per cent of potassuim sulphate, 92 per cent of the total potash present was obtained by simple ignition and subsequent leaching.

It is worth noting that, according to the laboratory experiments, 32.7 per cent of the ignited alunite consists of available potassium sulphate, which can be extracted by simple water leaching and evaporation. The remaining 67.3 per cent consists of nearly pure aluminum oxide.[1]

The deposit of alunite is located about 7 miles south of Marysvale, which is the present terminus of the San Pete & Sevier branch of the Denver & Rio Grande Railroad, near the head of Little Cottonwood Canyon, in and near sec. 16, T. 28 S., R. 4 W. The deposit ranges in elevation from about 11,000 feet above sea level to 9,900 feet at its lower end, which is about 4,000 feet above the railroad at Marysvale station.

The mineral occurs principally in the form of a large banded vein of the fissure type. The vein material occurs in massive form and has a porcelain-like appearance, varying in color from white to red, passing through various stages of pink.

A conservative estimate of the tonnage in this deposit may be had by assuming an average width of 10 feet in the principal vein for a length of 3,500 feet and neglecting the rest of the deposit as not sufficiently proved to be taken into consideration at present. This gives a surface area of substantially proved outcrop of 35,000 square feet, or about four-fifths of an acre. The specific gravity of the Marysvale alunite has been determined in several specimens by W. T. Schaller, with results in close accord at about 2.82. Therefore a cubic foot of the ore may be assumed to weigh about 175 pounds. An acre of ground underlain by this rock to a depth of only 1 foot would contain 3,800 short tons of alunite. If the area of the available alunite is only 35,000 square feet, as stated above, there would be approximately 300,000 short tons of the rock for each 100 feet of depth so long as the deposit maintains its surface dimensions and quality.[2]

If the recoverable alumina ($Al_2O_3$) is estimated at 35 per cent of this total, the deposit should yield 105,000 short tons of alumina for each 100 feet in depth. This is approximately 60 per cent of the yearly production of bauxite in the United States at the present time.

It will be remembered that bauxite contains considerable ferric oxide, silica, titanium oxide, and water. The average content in alumina of American bauxite being estimated at 55 per cent,[3] the alumina in the bauxite produced in 1911 amounted to 95,861 short tons. The estimated yield in alumina for each 100 feet in depth of the Marysvale alunite deposit is therefore nearly 10,000 short tons (9,139 tons) more than the present annual production in the United States.

The working of the alunite deposit for potash salts may be expected to contribute to no slight extent to the alumina resources of the United States. Whether it can compete with bauxite in the Eastern States is a difficult question to decide at the present, for as an offset to the freight charges from Utah to Mississippi River stands the fact that the alumina produced from alunite will presumably be so pure as not to require the chemical treatment which the bauxite of the Southern

[1] Op. cit., p. 58.
[2] Op. cit., p. 12.
[3] The average of 64 analyses in possession of the writer is 54.13 per cent.

States has to undergo before reduction to metallic aluminum. Moreover, the alumina from alunite is, in the nature of things, a by-product in the production of the more valuable potassium sulphate.

Besides the deposit of alunite at Marysvale, which seems to be the largest known at the present time in the United States, extensive deposits of the mineral are known to occur in the Rosita Hills, Colo. These deposits were the first extensive ones to be noted in the United States, and a report on the region, together with a geologic map, was published in 1896.[1] Other deposits in Colorado are located in the Rico Mountains, at Silverton, and at Cripple Creek. Other important occurrences in the Western States are at Goldfield, Nev.; at Tres Cerritos, Cal.; in the Clifton-Morenci district, Ariz.; and in Beaver County, Utah.

The foreign occurrences of alunite are very numerous; but the mineral has been worked abroad only at Tolfa, Italy, located about 35 miles northwest of Rome, and near the village of Bullah Delah, county of Gloucester, New South Wales, Australia. At both these places the mineral is employed chiefly in the manufacture of alum.[2]

## NOTES ON BAUXITE DEPOSITS.

*Arkansas.*—The great bulk of the bauxite produced in Arkansas in 1911 was mined by the American Bauxite Co. at the town of Bauxite. This town is located on the Chicago, Rock Island & Pacific Railway, 5 miles east of Benton, the county seat of Saline County, and 22 miles southwest of Little Rock, the State capital. The mines are located on the Bauxite & Northern Railway, a spur built from the St. Louis, Iron Mountain & Southern Railway system at Bauxite Junction. This spur crosses the Rock Island tracks at Bauxite station.

Five large mines were productive during the year, namely, the Tank, Steam Shovel, Martin, Mittie, and Maggie mines. A sixth mine, the Lantz, was stripped preparatory to mining; but at the time of the writer's visit late in October, no ore had come from it except that produced during the process of stripping. It is customary during the stripping to wash the material removed, and thus much valuable ore is saved. Stripping may reach a thickness of 40 to 50 feet, as at the Maggie mine; but this seems to be exceptional. At the Mittie mine the stripping did not exceed 10 to 15 feet.

The ore is worked in steps or benches when thick enough to admit of this method. The topmost bench, as at the Maggie mine, is from 6 to 10 feet above the next lower bench and broad enough to allow car and wagon tracks to run side by side. The next lower bench is approximately 10 feet wide. On this an old track formerly ran, which is now removed.

The ore is loosened by black powder. It is then shoveled into small cars. Steam shovels are not in use except for stripping, owing to the variable character of the ore, coupled with the necessity of securing as uniform an output as possible for particular purposes. The ore is shoveled into mine cars and conveyed to an excellent railroad running from the mines to the mill. The ore is not washed, but is dumped directly from the mine cars into crushers, the character of the crush-

[1] Cross, Whitman, Geology of Silver Cliff and the Rosita Hills, Colorado: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1896, pp. 263–403. Emmons, S. F., The Mines of Custer County, Colo.: Idem., pp. 405–472.

[2] Bull. U. S. Geol. Survey No. 511, 1912, pp. 51–57.

ing depending on the amount of moisture in the ore. Ore containing enough water to make it sticky is ground between two revolving crushers rotating in opposite directions. Dry ore goes through an ordinary Gates crusher. The ground or crushed ore is then conveyed to guns or rotary kiln dryers, similar to rotary cement kilns. These are now heated with natural gas under a pressure of 150 pounds. The gas comes from the Caddo field, Louisiana. The use of natural gas as fuel is something new at Bauxite. Its installation has resulted in a considerable saving, not so much in the fuel bill, for the cost of the gas is high, as in the simplicity of the firing, which does away with the services of many men. The dried ore is conveyed by a system of belt conveyers to storage bins and is loaded mechanically directly on the cars.

The bauxite beds rest directly upon kaolinized syenite. The surface of the syenite is undulating, and the bauxite bed which corresponds to that surface is likewise undulating. The ore has been proved to cover many of the hills completely, occurring on the sides as well as on the tops. It tapers out rather abruptly approaching the ravines and is lacking in many of them. In thickness the bauxite bed varies from a knife-edge up to a possible maximum of 30 feet.

The bauxite occurs in at least three forms, the granitic, the pisolitic, and the compact or claylike. Where the bed has been so opened as to show the underlying syenite, its lower part next to the syenite consists of granitic ore—that is, the ore is pseudomorphous after syenite. The second form of ore is pisolitic. The pisolites are small round bodies varying from the size of a pea up to an inch in diameter. In some places the ore has the appearance of gravel, the pisolites separating regularly from the matrix, which resembles clay. This type constitutes the gravel ore and may be worked with pick and shovel. In another variety of pisolitic ore the matrix and the pisolites are very compact and require blasting before removal. The claylike form is, as its name suggests, very little different in appearance from ordinary gray or reddish clay. Its character was entirely unsuspected for a long time, and only through chemical examination was its nature determined. It was found to be among the best ore of the district so far as its content of alumina ($Al_2O_3$) is concerned.

Three grades of ore are mined—that used in the manufacture of metallic aluminum, that used in the manufacture of alundum, and that used in the manufacture of aluminum salts. Only the ore containing less than 2 per cent of ferric oxide can be used in the manufacture of aluminum salts. The more ferruginous ore is used in the manufacture of metallic aluminum. A pure grade, which may, however, carry as much as 6 or 7 per cent of silica, is set aside for the manufacture of alundum by the Norton Co., of Worcester, Mass.

The ore has to be watched continuously. Even with much experience it is very difficult to tell good ore from bad without recourse to a chemical test, and shipments have to be checked constantly.

A section of a bauxite deposit which may be regarded as typical is as follows:

*Typical section of bauxite deposit.*

1. Surface sand and gravel.
2. Clay with halloysite (?) Very difficult and expensive to remove.
3. Bauxite.
4. Transitional phase between bauxite and syenite, composed chiefly of clayey material.
5. Unaltered syenite.

*Tennessee.*—Bauxite has been mined during the last five years on the east side of Missionary Ridge near Chattanooga, Tenn., by the National Bauxite Co. The deposits are conveniently reached by trolley to Sherman Heights and are about half a mile south of the tunnel of the Southern Railway, which pierces the ridge in this suburb.

Only one mine, the Perry mine, was worked during 1911. This mine, like most of those in northwestern Georgia and adjacent parts of Alabama, consists simply of a rounded or ellipsoidal open pit a few hundred feet in diameter at the surface and approximately 100 feet deep. Another mine or pit situated about 250 yards southwest of the Perry mine has produced bauxite. It has been excavated to a depth of 40 to 50 feet below the surface and now serves as a reservoir for water for the mill boilers. The work done at the mines also includes considerable surface stripping, but the actual depth of stripping necessary to reach the ore has been comparatively small, generally not more than 5 feet. Bauxite has also been found at points south of the mines on the east side of the ridge, has been noted at points as much as 2 miles east of the ridge, and is reported on the Lamb place, 2½ miles southeast of Tyner.

The ore is light in color as a rule. Some, in the upper mine, is of the pebble variety and some is of the pisolitic and oolitic varieties; the last by a decrease in the number of oolites becomes what is locally known as "block" ore. This is a fairly compact, light to dark olive-gray ore with an occasional pisolitic and oolitic grain. It is rich in alumina and low in both iron and silica. The bauxite is always associated with clay. There has also been observed in the southwest pit a body of lignite overlying the block ore. Such lignite masses are commonly associated with bauxite deposits. They have been observed near Fort Payne, Ala., and in the dike district in the same State. Many of the analyses of bauxite from the Perry mine communicated to the writer show a content of alumina between 50 and 55 per cent.

The ore is mined by pick and placed on small cars run on tracks radiating from a turntable. The cars are run up an incline to the top of the pit and thence to the washer or driers. These were erected during 1908 and have been used more or less intermittently ever since. The soft ore as mined contains considerable water and is dried to save freight costs. The hard ore contains less water and is separated in the pit and not dried. The pebble ore containing considerable clay is washed before drying. After the ore is prepared for shipment it is carted to a belt line on the ridge, and from this reaches the main line of the Southern Railway. Two carloads a day were being removed during November, 1911, the greater part of which went to Philadelphia for the manufacture of aluminum salts.

*Bauxite in Central Georgia.*—The first shipment of bauxite from the Wilkinson County field in central Georgia was made during the summer of 1910 by the National Bauxite Co. This company also produced bauxite in the same field during the year 1911.

These deposits have been described in detail in this chapter in previous annual reports. The deposits are in no way connected with those of northwestern Georgia, either geographically or geologically, being located 150 miles distant, near the margin of the Coastal Plain. Macon is the nearest city, located 30 miles to the west. The bauxite apparently occurs near the contact between the Lower Cretaceous

nd the Claiborne group (Tertiary Eocene) which are chiefly made
o of unconsolidated sands and clays lying practically flat and
aving no pronounced structural features. The bauxite occurs in
ne form of beds either resting directly upon the Cretaceous clays
disseminated as nodules through them. Bauxite beds 10 feet
ick have been observed.

The ore is generally either pisolitic or concretionary, but it is also
morphous, in which case it may be dense, halloysitic, or even flinty
appearance. Its color varies from almost white or cream to a
right red. It is generally hard, but claylike varieties have been
iscovered.

The points at which the bauxite is most likely to occur may be
pproximately located by finding the white clay beds, locally known
s the "chalk" beds, as the bauxite has been found contiguous to the
ay, near its contact with the overlying red sands and impure clays.
he geologic conditions prevailing in Wilkinson County are also
ound in Twiggs, Washington, Glascock, McDuffy, and Richmond
ounties, and bauxite may be found in any or all of these.

The following analyses have been recently made by Edgar Everhart,
f the Geological Survey of Georgia:[1]

*Analyses of bauxite from Wilkinson County, Ga.*

| $Al_2O_3$. | $Fe_2O_3$. | $SiO_2$. | $TiO_2$. | $H_2O$. | Moisture. |
|---|---|---|---|---|---|
| 52.92 | 7.66 | 10.17 | 2.30 | 26.55 | 0.35 |
| 57.58 | .96 | 9.38 | 2.76 | 29.12 | .35 |
| 41.97 | 18.24 | 17.50 | 2.65 | 16.83 | 2.65 |
| 57.36 | 1.94 | .90 | 3.65 | 32.44 | .67 |
| 42.73 | 14.99 | 15.57 | 1.84 | 20.29 | 2.79 |
| 61.77 | 1.67 | .90 | 2.26 | 31.77 | .95 |
| 60.64 | 1.33 | 2.30 | 2.00 | 30.58 | 2.79 |
| 61.00 | 1.94 | .74 | 2.66 | 32.93 | .46 |
| 60.54 | 1.94 | 1.96 | 2.01 | 32.51 | .35 |
| 62.46 | .81 | 4.72 | .23 | 31.03 | ..... |
| 49.94 | 9.32 | 8.32 | 1.98 | 27.24 | 1.94 |
| 39.92 | 16.84 | 20.00 | 1.47 | 19.52 | 1.25 |
| 60.55 | 1.89 | 2.12 | 1.96 | 32.97 | ..... |
| 61.52 | 1.70 | 1.18 | 2.70 | 32.76 | ..... |

The mining of bauxite in this region has not made very rapid
rogress. This slow development has been caused in part by dis-
utes over some of the land titles, which have led to long drawn out
tigation; another cause is the high price at which some of the owners
ave held their property.

## USES OF BAUXITE

The chief uses of bauxite were outlined in this report for 1910, as
ollows: (1) As raw material in the production of metallic aluminum;
2) in the manufacture of aluminum salts; (3) in the manufacture of
auxite bricks; (4) in the manufacutre of alundum (fused alumina)
or use as an abrasive. The use of bauxite in the manufacture of
alcium aluminate to give a quick set to plaster compositions should
e added, as well as the extended use which alundum is finding in the
efractory industries. The two latter uses are described in detail
arther on.

[1] McCallie, S. W., Eng. and Min. Jour., vol. 91, 1911, p. 1050.

1. The use of bauxite in the production of metallic aluminum is by far the most important of those enumerated above. A large part of the entire output of Arkansas is used in the metallic aluminum industry, and the figures of production from this State have shown phenomenal growth during recent years. A large part of the French product is also used in the manufacture of metallic aluminum.

2. Only the purer bauxite is used in the manufacture of chemicals, such as alum, aluminum sulphate, and aluminum salts in general. Freedom from oxide of iron is essential in the material to be used in the chemical manufactures.

3. The use of bauxite in the manufacture of refractory brick has by no means reached a perfected stage, but it is understood that several manufacturers are now experimenting on processes in which it is admixed with other materials. The life of bauxite-brick linings is as yet undetermined, though it is known to exceed by far the life of silica brick or fire-clay brick. The high cost of raw material, as well as that of its manufacture, makes the ultimate cost of bauxite brick excessive as compared with that of the other two bricks mentioned.

4. Bauxite is used on a large scale in the manufacture of the artificial abrasive, alundum, at Niagara Falls. This abrasive is made in the electric furnace by fusing calcined bauxite. It is high in crystalline aluminum oxide, and virtually amounts to a form of artificial corundum. Its quality is under complete control, and hence it can be duplicated with ease in the various abrasive products, a factor of great importance in any successful abrasive industry. Alundum is particularly efficient in the grinding of steel.

*New use for alundum.*—L. E. Saunders,[1] of the Norton Co., of Niagara Falls, has recently presented data on the value of alundum (electrically fused alumina) as a refractory. Alundum was primarily developed as an abrasive, but its resistance to heat and its other valuable qualities listed below have led to its introduction into the field of the refractories.

There are two forms of alundum of interest in this connection—a white crystalline product with less than 1 per cent of impurities, and a reddish-brown vitreous product with 6 to 8 per cent of impurities, consisting of oxides of iron, titanium, and silicon. The purer white product melts between 2,050° and 2,100° C., the brown product at not more than 50° lower. The coefficient of expansion is low. The thermal conductivity is from three to four times that of most fire clay. The hardness of the material is about 9 in Moh's scale. Both the white and the colored varieties are quite unattacked by aqueous acids and alkalies, and only very superficially by fused carbonates. Basic and acidic slags dissolve it with some difficulty, acidic slags having a readier action.

The easiest method of preparing the different articles consists in mixing the crushed grains with a binding agent of a refractory and ceramic nature, molding the desired pieces after the manner of the potter, and burning them in a kiln. Some attempts have been made to mold the shapes from the liquid material, but they have met with only partial success.

The articles thus far turned out are mostly porous, consisting of more or less finely divided grains held together by a ceramic bond. This porosity renders them unfit for any work in which a gas-tight

[1] Met. and Chem. Eng., April, 1911, p. 225; May, 1911, p. 257.

chamber is required, but, on the other hand, is very advantageous in another way, for the porosity can be varied to such a degree that crucibles and dishes may be made for filtering purposes. The Gooch type of crucibles or filtering dishes, for example, made of this material, serve perfectly in analytical work. They save time in the laboratory, and as they are quite unattacked by acid or alkali they may be used in most analytical processes. Other articles which have been made are mufflers of many shapes and sizes, combustion boats, extraction thimbles, filter tubes, filter dishes, electrical furnace sections and parts, corrugated furnace cores, arc-lamp economizers, tubes, etc. Alundum bricks have been made experimentally, but the high cost of manufacture and their great weight make them available only in special cases. They are well adapted to the roofs of electric furnaces on account of their high melting point and low coefficient of expansion.

*Use of bauxite in calcium aluminate.*—Henry S. Spackman and E. W. Lazell have taken out a series of patents (Nos. 903017–903020, dated November 3, 1908) on cementitious material and its preparation, in which use is made of the mineral bauxite. The inventions relate more particularly to the preparation of plaster compositions by the incorporation in them of hydraulic calcium aluminate to give them a quick set. Hydraulic calcium aluminate compounds may be prepared by mixing in proper proportions finely ground lime and bauxite or other alumina compounds, such as kaolin or high alumina clays, high alumina slag, etc. Such mixtures may be rendered hydraulic and given a quick initial set when dried, ground, and mixed with water by calcining and sintering them. If desired, the temperature may be carried higher, so as to effect fusion.

The preparation of a type of plaster composition is given as follows:

Eighty-six parts of dry hydrated lime, 10 parts of calcium aluminate accelerating material containing approximately 40 per cent of alumina, 2 parts of plaster of Paris, and 2 parts of infusorial earth are thoroughly incorporated and finely ground together. This material when prepared so that 95 per cent may pass through a 100-mesh sieve has an initial setting time of about 4 hours and is completely set in about 15 hours, according to the standard Vicat needle test. A sample of this highly cementitious material when tested in the ordinary way with 3 parts of commercial sand in air gives the following high tensile strengths: At 7 days 125 pounds per square inch, and at 28 days 151 pounds per square inch. A plaster composition having less tensile strength and therefore being more desirable as a general wall finish in building operations may be similarly prepared by incorporating 88 parts of dry hydrated lime, 7 parts of hydraulic calcium aluminate accelerating material containing approximately 40 per cent of alumina, 3 parts of plaster of Paris, and 2 parts of basic blast-furnace slag. This plaster material when tested in the ordinary way with 3 parts of commercial sand in air gives about 50 pounds tensile strength per square inch at 7 days, and about 90 pounds at 28 days. When used as a plaster as much as 5 parts of commercial sand can be readily incorporated therewith and give the desired spreading qualities for wall finishing, the plaster hardening completely so as to allow the application of a finishing coat in about 12 hours.

## METHOD OF PURIFYING BAUXITE.

N. Lecesne has patented a mechanical method for removing most of the impurities from bauxite (French patent No. 424514, dated December 31, 1910). The bauxite after being air dried, or dried by heating, is disintegrated in any form of apparatus in which it is subjected to impact, as contrasted with grinding or crushing. The dust which contains most of the ingredients other than alumina is eliminated as produced or subsequently by means of a fan, leaving a granular concentrate rich in alumina. In order to get rid of iron more completely,

the bauxite may be dried by heating in a reducing atmosphere of 350° or 400° C., and the magnetic oxide thus produced may be separated electromagnetically. As an example, bauxite containing 3 per cent of silica and 60 per cent of alumina may thus be made to yield a concentrate containing less than 1 per cent of silica and as much as 86 per cent of alumina.

## ALUMINUM.

### PRODUCTION.

The magnitude of the aluminum industry is shown in the table following, which gives the production since the beginning of the industry in 1883 and the domestic consumption of the metal since 1904.

*Production, in pounds, of aluminum in the United States, 1883–1911.*

| | | | |
|---|---|---|---|
| 1883 | 83 | 1899 | 6,500,000 |
| 1884 | 150 | 1900 | 7,150,000 |
| 1885 | 283 | 1901 | 7,150,000 |
| 1886 | 3,000 | 1902 | 7,300,000 |
| 1887 | 18,000 | 1903 | 7,500,000 |
| 1888 | 19,000 | 1904 | [1] 8,600,000 |
| 1889 | 47,468 | 1905 | [1] 11,347,000 |
| 1890 | 61,281 | 1906 | [1] 14,910,000 |
| 1891 | 150,000 | 1907 | [1] 17,211,000 |
| 1892 | 259,885 | 1908 | [1] 11,152,000 |
| 1893 | 333,629 | 1909 | [1] 34,210,000 |
| 1894 | 550,000 | 1910 | [1] 47,734,000 |
| 1895 | 920,000 | 1911 | [1] 46,125,000 |
| 1896 | 1,300,000 | | |
| 1897 | 4,000,000 | Total | 239,751,779 |
| 1898 | 5,200,000 | | |

### EXPORTS.

The value of exports of aluminum and of manufactures of aluminum of domestic production for the last five years has been as follows:

*Exports of aluminum of domestic production, 1907–1911.*

| | | | |
|---|---|---|---|
| 1907 | $304,938 | 1910 | $949,215 |
| 1908 | 330,092 | 1911 | 1,158,603 |
| 1909 | 567,375 | | |

### NEW PLANT FOR MANUFACTURE OF METALLIC ALUMINUM.

It is reported that the National Aluminum Co. of the United States, with headquarters at Clarksburg, W. Va., began to manufacture metallic aluminum and its compounds in January, 1912. The process employed is electrochemical, and was perfected and brought into line with modern electric furnace practice by this company to suit its shaft furnace. This furnace was recently patented by Harold A. Danne (Patent No. 958855, dated May 24, 1910).

### MANUFACTURE OF METALLIC ALUMINUM.[2]

In an article by William Clacher in the London Electrical Review of January 20, 1911, some interesting details are given of the cost of the manufacture of metallic aluminum as carried out by the British Aluminum Co. (Ltd.). In the same issue Clacher describes the details

[1] Consumption. The figures for 1911 do not include the weights of imported leaf aluminum and of miscellaneous manufactures of aluminum, whose values were, respectively, $1,980 and $12,760.

[2] Met. and Chem. Eng., vol. 9, No. 3, 1911, pp. 146–147.

of the manufacture of carbon electrodes as carried on at the works of the same company at Greenock and Kinlochleven. The alumina is obtained from bauxite by dissolving the latter in caustic soda and precipitating the alumina by the addition of some previous precipitated alumina. It is then filtered off, washed, partly dried in the filter, and calcined in a furnace at a cherry-red heat, after which the hard amorphous alumina is ready for transportation in bags to the electric furnaces.

In the electric furnaces the molten electrolyte consists of alumina and its flux cryolite. The reduction of the alumina takes place at the point of contact of the carbon anodes, which oxidize and burn away, the gases going into the atmosphere. Hydrofluoric-acid gas is also evolved from the cryolite used. The metal produced sinks to the bottom of the furnace and is tapped away. The resistance of the carbon blocks is tested at the furnace. They are 10 inches square and are arranged in sets of 12 in the furnace. The direct current for operating is obtained from 50-volt dynamos. The plate for the bottom of the furnace is of cast iron and has somewhat the form of a grid. The interspaces are filled with carbon, which is rammed, and the whole plate is covered, making the contact between the carbon lining of the furnace and the cable much more effective.

The metal produced is of a high degree of purity, a percentage greater than 99.5 being usual. The carbon used, however, is 99 per cent pure and the alumina is 99.9 per cent pure. The metal as it comes from the furnace is afterwards melted and the pure metal free from any mechanical admixture is molded into ingots, which are bagged and dispatched to the foundry or mill to be worked into sheets, alloys, and castings.

The power used is water power, the most economical source of energy. The allocation of costs is given as follows:

*Cost per long ton of production of metallic aluminum in Great Britain.*

| | |
|---|---|
| Energy | $25.00 |
| Carbon | 32.50 |
| Alumina | 140.00 |
| General expenses and profit | 140.00 |
| Total | 337.50 |

## ALUMINUM MARKET.[1]

Late in November, 1910, the market price of metallic aluminum in the form of No. 1 ingots f. o. b. New York City, was 22½ to 23 cents per pound. These figures held until the end of the year, when No. 1 ingots could be obtained at 22½ cents per pound, with the market still on the decline at the beginning of 1911. During the early part of January, 1911, the aluminum market was weak and prices were lower, No. 1 ingots bringing 21 to 22 cents per pound. The market continued dull and at the end of the month quotations were 20½ to 21 cents. The tone of the market was slightly better the first week in February, but throughout this month business was very quiet and prices ranged from 21 to 21½ cents. These prices continued throughout March. At the beginning of April there was no interest in the

[1] Under the Payne-Aldrich tariff act of August, 1909, aluminum, aluminum scrap, and alloys of any kind in which aluminum is the component material of chief value, in crude form, are dutiable at 7 cents per pound and plates, sheets, bearings, and rods at 11 cents per pound, instead of 8 cents and 13 cents respectively.

market, very little business was done, and quotations were slightly lower, namely, 20¾ to 21¼ cents. Prices soon became still weaker and during the first week in April they fell to 20½ to 21 cents. These prices continued until nearly to the end of May when they became still lower, and metal could be bought at 20 to 20½ cents. The low prices continued until early in June when another fall to 19¾ to 20¼ cents occurred. There was no perceptible change in market conditions until early in July when business became slightly more active and prices ranged from 20 to 20¼ cents. These prices held until late in August when a fall occurred to 19¾ to 20 cents per pound. The sales in early September were not large and the market remained quiet at 19¾ cents, falling to 19½ cents per pound in large lots. French producers were pressing metal for sale and active competition and low prices prevailed in the foreign market Owing to the pressure of foreign metal, prices fell to 19 to 19½ cents in late September and continued to fall, metal selling as low as 18½ to 19 cents early in October. These prices held until late November, and in early December they became a shade higher, namely, 18⅝ to 19 cents, soon rising to 18¾ to 19¼ cents. Business was very dull the last week in the year and prices ranged from 18½ to 19 cents per pound. Little business was reported at the beginning of 1912, and prices remained as above during the first half of January of this year. In the accompanying illustration (fig. 13) the fluctuations in the price of metallic aluminum in the form of No. 1 ingots f. o. b. New York City is illustrated graphically for the years 1910 and 1911.

## ALLOYS.

*Action of impurities on metallic aluminum.*[1]—The natural impurities associated with metallic aluminum are silicon, iron, titanium, sodium, and potassium. The action of these elements together with others present in the alloys of the metal is briefly outlined below:

Calcium and titanium are found very rarely associated with aluminum and are easily extracted. The element titanium has a favorable influence on aluminum if present in quantity not exceeding 3 per cent; an alloy, for example, containing 2 per cent of titanium offers great resistance to tensile stresses. Iron and silicon add luster to aluminum and make it hard. The metals of the alkalies like sodium act in a deleterious manner, as they offer no resistance to dampness or air. Aluminum bronze contains 7½ to 10 per cent copper; when more copper is present the alloys are brittle. An alloy of aluminum with less than 50 per cent zinc is so homogeneous that the two metals can not be recognized under the microscope. Nickel increases the elasticity of the metal. Magnesium aluminum alloys are expensive but very light; they are, however, not so resistant to destruction as other alloys. Manganese and chromium increase the hardness of aluminum, but with 50 per cent of chromium the alloy can not be worked. Tin in small quantities makes aluminum fragile. Tungsten hardens aluminum and increases its resistance to destructive influences.

*Improved process of manufacturing aluminum alloys.*[2]— It has been found difficult to produce a composite metal containing an appreciable quantity of aluminum and having the properties of malleability and

[1] Met. and Chem. Eng., February, 1911, p. 107. [2] Met. and Chem. Eng., April, 1911, p. 219.

ductility. J. G. and W. F. Mellen have patented a process (patent No. 982218, dated Jan. 17, 1911) which they claim enables them to produce an aluminum alloy with copper or other metal which retains the valuable properties mentioned. Their process gives an alloy with specific gravity lowered and color modified by aluminum. As a general rule it may be stated that the greater the proportion of aluminum in the alloy the lighter will be the resulting metal both in color and weight, and also the harder and less malleable and ductile. In the preparation of the alloy the copper is weighed and melted in a pot. When the temperature has been raised to the proper point the proper quantity of aluminum is added; then, when the aluminum has melted, an oxidizing agent like potassium bichromate and a flux like borax are added in the proportion of one-half pound of the former and one-quarter pound of the latter to each 100 pounds of alloy. A violent reaction takes place owing to the oxidation of the aluminum. This brings about an intimate mixture of the metals, the failure to obtain which has been the cause of former unsatisfactory alloys of aluminum.

*Other alloys.*—P. H. G. Durville has patented the use of manganese as a purifier for copper aluminum alloys (patent No. 1007548, dated October 31, 1911). He uses the following composition: 86 to 95 per cent

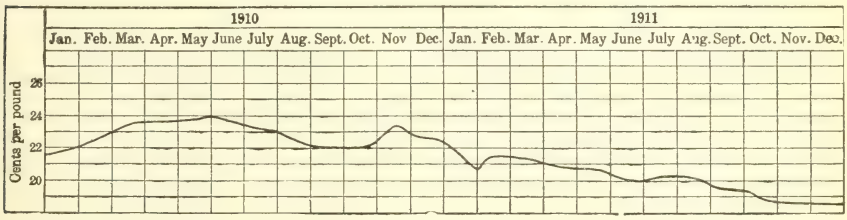



FIGURE 13.—Curve showing price by months in 1910 and 1911 of metallic aluminum in form of No. 1 ingots f. o. b. New York City.

of copper, 0.05 to 5 per cent of manganese, and 6 to 11 per cent of aluminum. The metals can be melted in the order indicated, but a portion at least of the manganese must be added in the form of an alloy with copper or aluminum at the time of casting. Manganese in small proportions plays the part of a purifier as regards impurities other than oxides, which are not removed from the alloy by aluminum. The greater the proportion of manganese up to 5 per cent the greater the hardness and malleability of the alloy. These alloys have all the qualities of binary aluminum bronzes (consisting of copper and aluminum only), that is, great strength, good color, and resistance to chemical agents, and they are very easy to work. They are characterized moreover by the advantage that very sound ingots are obtained which can be easily forged, stamped, rolled, or drawn.

C. H. H. Claessen has patented an improved alloy in which use is made of magnesium and copper, the former not exceeding 2 per cent in quantity and the latter not exceeding 5 per cent (patent No. 995131, dated June 13, 1911). The alloy is claimed to be light, and at the same time stronger and of better quality than either aluminum or the present alloys of that metal.

Joseph N. Daudelin (patent No. 989573, dated April 18, 1911) has patented a new solder formula comprising a mixture of silver, phos-

phorus, copper, lead, tin, aluminum, and zinc. These various ingredients are claimed to make the solder run easily and be of use for aluminum as well as other metals. It is claimed that the solder has a low coefficient of expansion, great tensile strength, is homogeneous, will not corrode easily, and is tough without being brittle.

It is claimed that a new alloy consisting of about 78 per cent of aluminum, 8 per cent of copper, and 5 per cent of tin has the following advantages: It may be easily and economically cast. The castings are homogeneous, free from dross, and of such density that they need not be subjected to pressure. They may be finished without a lubricating agent, and the finished object has a beautiful, lustrous appearance. The copper contents of the alloy may vary between 7 and 8.5 per cent and the tin between 4.5 and 5.5 per cent, but in any case the percentage of copper must exceed that of the tin.[1]

## RECENT APPLICATIONS OF METALLIC ALUMINUM AND ITS ALLOYS.

Certain new alloys were mentioned in this report for 1910—namely, duralumin, cupsor, clarus, and atherium. Of these, the first mentioned has attracted more than ordinary attention. It is reported that at the works of the Electric & Ordnance Accessories Co. (Ltd.), at Aston, Birmingham, England, two test pieces were cut from square bars of duralumin of 0.75 of an inch section and reduced in the lathe to 0.401 inch. The first withstood a tensile strength of 7,170 pounds, equal to 25.35 tons per square inch, with an elongation of 26 per cent and a contraction of area amounting to 0.3 inch, or 44 per cent; and the second showed a tensile strength of 7,260 pounds, or 25.7 tons per square inch, an elongation of 27 per cent, and a contraction of area exactly the same as in the first case. The uniform results yielded by these experiments indicate that the difficulties encountered in the earlier history of this alloy, when the yield exhibited great variations in character, have been largely surmounted.

The new naval airship which has been constructed for the British Government and which was brought out of the building shed at Barrow-in-Furness, Lancashire, on May 22, 1911, has a light frame made of the new alloy duralumin. This alloy contains about 91 per cent of aluminum, and has a specific gravity between 2.77 and 2.84, with strength and hardness about equal to that of mild steel. The balloon is 512 feet long by 48 feet wide, and is formed in 17 sections or compartments. These together have a capacity of 706,330 cubic feet and a lifting capacity of 21 tons. The structure is worked by two sets of engines, two of the engines being of 200 horsepower each. The use of duralumin for the framework of this naval airship, as it is termed, and of aluminum for painting the silk of which the balloon proper is formed, points to fields of use for the metal which have not hitherto been in public view.[2]

The use of aluminum or its alloys in automobiles, dirigible balloons, and aeroplanes is constantly increasing. In the form of the alloy magnalium, aluminum is used in the beams of analytical balances. Aluminum is also employed in paper decorations and for wrapping. It has been used in the textile industries, where it has been combined with silk, to which it imparts a brilliancy particularly adapted to ceremonial and theatrical costumes. In addition to these uses, it is also employed in the manufacture of reticules, scarfs, and various articles of use and ornament, and because of the high price of copper it has been largely used as a substitute for that metal in the manufacture of electrical cables.

[1] Eng. and Min. Jour., May 13, 1911, p. 948.

[2] Min. Science, July 6, 1911.

The Ordnance Department of the United States Army recently awarded a contract to the Aluminum Goods Manufacturing Co., of Two Rivers, Wis., for 62,678 aluminum canteens and cups, model of 1910. Metallic aluminum is now being used extensively in other ways for light field equipment. Supplementing the canteen and cup is an aluminum combination frying pan and meat dish, which, with knife, fork, and spoon inside, folds up and may be hung to the soldier's belt. The fork, spoon, and handle of the knife are of aluminum; the knife blade is made of steel.

## ALUMINUM SALTS.

### NEW SOURCE OF ALUMINUM SALTS

A large deposit of wavellite or related mineral is reported to have been recently discovered near Mitchell Mountain, on Coosa River, 6 miles east of Coal City, St. Clair County, Ala. The deposit is about 6 miles from the railroad but is on the navigable part of the river. The property is included in 2,300 acres, in which are large deposits of brown iron ore.

Wavellite is a phosphate and hydrate of aluminum, with water of crystallization, having the formula $4AlPO_4.2Al(OH)_3.9H_2O$, and containing, when perfectly pure, phosphorus pentoxide ($P_2O_5$) 35.2 per cent, alumina ($Al_2O_3$) 38 per cent, and water ($H_2O$) 26.8 per cent.

The following notes regarding the deposit have been furnished to the Survey by the owners of the property:

The wavellite outcrops along the river and in the wagon road for half a mile. It is present in sheets, stringers, and mammillary masses, more or less cavernous, and fragments of the mineral are scattered about mixed with the clayey and sandy ferruginous débris of the region. Prospects have been driven into practically pure masses of wavellite. The mineral is pale green in color, and the characteristic radiating structure may be observed when the specimens are broken. Associated with the wavellite is a greenish sandy clay weathering brown when exposed to the air. When finely crushed the wavellite may be separated by flotation processes from the siliceous and ferruginous impurities. The content of iron in the mineral is reported to be very low.

Plans are being perfected to mine the ore, ship it to Rome, Ga., and manufacture it into sodium phosphate, aluminum phosphate, and other aluminum salts. It is also quite probable that the material may in part be shipped to chemical factories in the North.

### PRODUCTION.

The following table gives the domestic production, the imports, and the value of aluminum salts from 1907 to 1911, inclusive:

*Production and imports of aluminum salts into the United States, 1907–1911, in short tons.*

| Year. | Production. | | | | | | Imports.[a] | |
|---|---|---|---|---|---|---|---|---|
| | Alum. | | | Aluminum sulphate. | | | Quantity. | Value. |
| | Quantity. | Value. | Per ton. | Quantity. | Value. | Per ton. | | |
| 1907 | 10,404 | $361,900 | $34.78 | 106,821 | $2,008,046 | $18.80 | 1,562 | $35,191 |
| 1908 | 7,700 | 236,710 | 30.74 | 97,255 | 1,835,213 | 18.87 | 1,407 | 24,929 |
| 1909 | 9,237 | 295,682 | 32.01 | 115,366 | 2,214,122 | 19.19 | 1,459 | 29,061 |
| 1910 | 9,090 | 300,763 | 33.09 | 126,792 | 2,447,552 | 19.30 | 2,127 | 53,671 |
| 1911 | 10,468 | 329,686 | 31.49 | 134,077 | 2,743,336 | 20.46 | 2,283 | 56,833 |

[a] Includes alumina, aluminum hydrate, or refined bauxite, alum, alum cake, aluminum sulphate, aluminous cake, and alum in crystals or ground.

## BIBLIOGRAPHY.

The more important publications in English treating of bauxite, aluminum, and aluminum salts are listed below. This list includes also the principal latest papers devoted mainly to the technology of aluminum.


Ashley, G. H , Bauxite mining in Tennessee: The resources of Tennessee, vol. 1, no. 6, 1911, pp. 211–219.

Aubrey, A. J., The refractory uses of bauxite: Eng. and Min. Jour., Feb. 3, 1906, pp. 217–218.

Berger, W. F. B., Bauxite in Arkansas: Eng. and Min. Jour., Apr. 14, 1904, pp. 606–607.

Branner, J. C., The bauxite deposits of Arkansas: Jour. Geology, vol. 5, 1897, pp. 263–289.

Butler, B. S., and Gale, H. S., Alunite, a newly discovered deposit near Marysvale, Utah: Bull. U. S. Geol. Survey No. 511, 1912, 64 pages.

Engineering and Mining Journal, Bauxite brick: Issue for Jan. 19, 1905, p. 154.

Hayes, C. W., Bauxite: Mineral Resources U. S. for 1893, U. S. Geol. Survey, 1894, pp. 159–167.

——— The geological relations of the southern Appalachian bauxite deposits: Trans. Am. Inst. Min. Eng., vol. 24, 1895, pp. 243–254.

——— Bauxite, its occurrence, geology, origin, economic value: Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1895, pp. 547–597.

——— The Arkansas bauxite deposits: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 3, 1901, pp. 435–472.

——— Bauxite in Rome quadrangle, Georgia-Alabama: Rome folio (No. 78), Geol. Atlas U. S., U. S. Geol. Survey, 1902, p. 6.

——— The Gila River alum deposits: Bull. U. S. Geol. Survey No. 315, 1907, pp. 215–223.

Holland, T. H., The occurrence of bauxite in India: Records Geol. Survey India, vol. 32, pt. 2, 1905, pp. 175–184.

Horton, J., The manufacture of aluminum: Trans. Eng. Soc. School of Prac. Sci., Toronto, No. 18, 1905, pp. 113–123.

Hunt, Alfred E., Aluminum (and bauxite): Mineral Resources U. S. for 1892, U. S. Geol. Survey, 1893, pp. 227–254.

——— Bauxite: Trans. Am. Inst. Min. Eng., vol. 24, 1895, pp. 855–861.

——— Aluminum, Aluminum Co. of America, Pittsburgh, Pa., 1904, 268 pages.

Institution of Mechanical Engineers, Minutes of meeting, alloys of aluminum and copper: Engineering, Mar. 8, 1907, pp. 299–307.

Judd, Edward K., Aluminum: Mineral Industry during 1905, pp. 11–22.

——— The bauxite industry of the South: Eng. and Min. Jour., Mar. 23, 1907, pp. 574–575.

——— Bauxite: Mineral Industry, vol. 16, 1908, pp. 97–102.

McCalley, H., Bauxite: The valley regions of Alabama, pt. 2, Alabama Geol. Survey 1897, pp. 79–84; also descriptions of Calhoun and Cherokee counties.

McCallie, S. W., Bauxite deposits of southern Georgia: Eng. and Min. Jour., May 27, 1911, p. 1050.

Minet, Adolphe (translated with additions by Leonard Waldo), The production of aluminum and its industrial use, 1st edition, John Wiley & Sons, New York, 1905, 266 pages.

Packard, R. L., Aluminum (and bauxite): Mineral Resources U. S. for 1891, U. S. Geol. Survey, 1892, pp. 147–163.

——— Aluminum: Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1895, pp. 539–546.

Paint, Oil, and Drug Review, Aluminum paints: Issue for Aug. 15, 1906, p. 30.

Phalen, W. C., Bauxite and aluminum: Mineral Resources U. S. for 1909, pt. 1, U. S. Geol. Survey, 1911, pp. 561–572.

PHALEN, W. C., Bauxite and aluminum: Mineral Resources U. S. for 1910, pt. 1, U. S. Geol. Survey, 1911, pp. 711–723.

PHILLIPS, WM. B., and HANCOCK, DAVID, The commercial analysis of bauxite: Jour. Am. Chem. Soc., vol. 20, 1898, pp. 209–225.

RICHARDS, JOSEPH W., Aluminum, its history, occurrence, properties, metallurgy, and applications, including its alloys, 3d ed., Baird & Co., Philadelphia, 1896.

——— The metallurgy of aluminum in 1906: Mineral Industry, vol. 15, 1906, pp. 15–27; Eng. and Min. Jour., June 8, 1907, pp. 1083–1086; Eng. and Min. Jour., June 15, 1907, pp. 1147–1149.

SCHNATTERBECK, C. C., Aluminum and bauxite: Mineral Resources U. S. for 1904, U. S. Geol. Survey, 1905, pp. 285–294.

SPENCER, J. W., Bauxite (the Paleozoic group): Georgia Geol. Survey, 1893, pp. 214–239.

SPURR, J. E., Alum deposits near Silver Peak, Esmeralda County, Nev.: Bull. U. S. Geol. Survey No. 225, 1904, pp. 501–502.

STACY-JONES, J. E., Light aluminum alloys: Indust. World, May 11, 1907, pp. 593–596.

STRUTHERS, JOSEPH, Aluminum and bauxite: Mineral Resources U. S. for 1903, U. S. Geol. Survey, 1904, pp. 265–279.

SUTHERLAND, JAMES, The preparation of aluminum from bauxite: Eng. and Min. Jour., Oct. 3, 1896, pp. 320–322.

VEATCH, OTTO, Report on the bauxite deposits, Wilkinson County, Ga.: Bull. Georgia Geol. Survey No. 18, Appendix D, 1909, pp. 430–447.

WATSON, T. L., The Georgia bauxite deposits, their chemical constituents and genesis: Am. Geologist, vol. 28, 1901, pp. 25–45.

——— Bauxite deposits of Georgia: Bull. Georgia Geol. Survey No. 11, 1904.

WETHERELL, E. W., Laterite in Mysore: Mysore Geol. Dept. Memoirs, vol. 3, pt. 1, pp. 27.

# TUNGSTEN.

By Frank L. Hess.

## GENERAL CONDITION OF THE TUNGSTEN INDUSTRY.

There was a sharp falling off in the production of tungsten ore in 1911, owing to the decrease in the market for tool steels, in which the bulk of the tungsten produced is used. Ore and concentrates equivalent to 1,139 short tons carrying 60 per cent tungsten trioxide were produced and shipped during the year, which is less than two-thirds of the output for 1910, when 1,821 tons were marketed. Dullness in the steel trade involves dullness in the tungsten market.

The statement of production just made does not mean that each lot of tungsten ore shipped from the mines carried 60 per cent of tungsten trioxide, but that all shipments as reported to the United States Geological Survey have been reduced to an equivalent quantity of ore carrying 60 per cent $WO_3$. As a matter of fact the ores shipped carry from 20 per cent to more than 72 per cent of tungsten trioxide.

*Alaska.*—Prospecting on the Crim, Randt, and O'Brien tin deposits along Cassiterite Creek, a tributary of Lost River, about 100 miles northwest of Nome, is reported to have shown deposits of wolframite that can be worked profitably.

*Arizona.*—A small quantity of high-grade hübnerite was produced in 1911 from the placers 4 or 5 miles north of Dragoon. The placers are "dry washings," no water being available, and for a number of years have yielded a small annual output of excellent ore.

A number of carloads of wolframite was mined near Arivaca, not far from the Mexican boundary. It was hauled to Tucson, whence it was shipped to Denver for milling.

A small quantity of cobbed wolframite was shipped from the Boner Canyon district in the Aquarius or Aquerra Range near Owens on Big Sandy River. The deposit is 57 miles from Kingman and 40 from Hackberry. Twelve miles of the route is by trail.

*California.*—As before, the most of the tungsten ore produced in California was scheelite, mined at Atolia. Work was carried on by the Atolia Mining Co. through nearly the whole year, but the output was not so large as in 1910. A promising new vein was discovered on the Attilla claim, north and east of the veins hitherto worked.

A small quantity of scheelite was taken from the Cock Robin claim, and a small quantity was mined from the dry placers between Atolia and Randsburg.

In the Clark Mountains, near Nipton, a few tons of wolframite and scheelite were mined, only part of which was shipped.

*Colorado.*—The lack of demand for tungsten was severely felt in the Boulder field, and the output was equivalent to only 730 tons of concentrates, carrying 60 per cent of tungsten trioxide, against 1,221 tons in 1910. Many of the mines were closed for a large part of the year. The Primos Mining & Milling Co., which had started to sink a shaft 1,000 feet deep, stopped work when it was less than half completed. About the middle of the year the company closed down all of its mines and both mills to await a better demand. The old mill at Cardinal was used in 1911 to work over the tailings that had accumulated during the number of years that tungsten ore had been treated at the mill. The Lakewood mill, 1½ miles north of Nederland, worked part of the year both on ore from the company's mines and on purchased ore. The Wolf Tongue Mining Co. took advantage of the dull season to build a reenforced concrete mill building to take the place of the old building. The machinery was rearranged. Card concentrating tables and Monell slimers are now used. The company put in a new hydroelectric plant, which can be used about nine months of the year, and a steam plant, which will be used during the remainder of the time.

Ardourel & Smith's mill worked most of the year on Wolf Tongue Mining Co.'s tailings, but also handled some ore.

The Tungsten Mountain Mines Co.'s mill worked over some old dumps and afterwards milled a quantity of ore from the mine. Although assays of tungsten ores from the district usually show a little gold and silver, none was caught on amalgamated plates used in this mill.

On the Rogers tract considerable mining was done under the general charge of Eugene Stevens.

In spite of the dullness several new companies were organized to mine and mill tungsten ore.

During the year announcement was made of the discovery of wolframite on Farncomb Hill, Breckenridge, Summit County, but only small veinlets were found and they do not promise to become of commercial importance. Some specimens sent to the Survey are as black as the ferberite of Boulder County, but the crystals are different in form.

A little prospecting was done upon hübnerite deposits near Silverton, San Juan County, but no production is known to have been made.

*Idaho.*—The production of hübnerite concentrates made on Patterson Creek in the Blue Wing district, Lemhi County, was not as large as had been expected, owing to defective machinery and to other causes. Mackay, on the Oregon Short Line, 60 miles south, has been the shipping point for the district, but a road to Leadore, 25 miles east, is under construction. Nothing was done during the year on the scheelite at Murray.

*Montana.*—No production of tungsten ore was reported from Montana during 1911, but hübnerite was found in quartz veins that were once worked for silver in the Potosi district, 8 miles southwest of Pony. The hübnerite occurs in needles ranging in color from light yellowish brown to dark reddish brown and is associated with galena, greenish yellow sphalerite, pyrite, and chalcopyrite.

Some prospecting was done on scheelite-bearing veins in the Sheepeater district, near Jardine, Park County.

*Washington.*—Only one small lot of tungsten ore was reported from Washington in 1911. It came from near Deer Park, Stevens County. Forest fires so cleared the ground that prospecting was made much easier, and it is reported that hübnerite has been found over a larger area than that in which it was formerly known. No production was made in Cedar Canyon, the mine and mill being closed most of the year.

In the northwest part of Okanogan County, near the Canadian boundary, prospecting and development work was done on quartz veins carrying a very dark wolframite. The deposit is 35 miles by trail from Loomis.

*Nevada.*—A mill erected in 1910 was operated for a short time on the hübnerite deposits in the Snake Range at Hub, 12 miles south of Osceola, and 45 miles southeast of the railroad at Ely. The company became involved in financial troubles and its concentrates reached the market when prices were low, so that it did little work during the year.

The hübnerite properties near Regan were prospected under option during the year. Bismuthinite occurs with the ore and should add to its value.

No production was made at Round Mountain during the year, but a mill was being erected at the close of the year, and development work was prosecuted on several claims.

*Other States.*—Tungsten deposits occur in the Black Hills of South Dakota and in New Mexico, and although they have been prospected to some extent they have yielded no known production.

## PRODUCTION.

The production of domestic tungsten ore in 1911 amounted to 1,139 short tons of concentrates, carrying 60 per cent tungsten trioxide, which is very close to the preliminary estimate (1,125 tons) made by the Survey.

The production of tungsten ore in the United States has been recorded only since 1900; before that time it was insignificant. As obtained by the United States Geological Survey the figures are as follows:

*Production of concentrated tungsten ores in the United States, 1900–1911, in short tons.*[a]

| Year. | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1900 | 46 | $11,040 | 1906 | 928 | $348,867 |
| 1901 | 179 | 27,720 | 1907 | 1,640 | 890,048 |
| 1902 | 184 | 34,040 | 1908 | 671 | 229,955 |
| 1903 | 292 | 43,639 | 1909 | 1,619 | 614,370 |
| 1904 | 740 | 184,000 | 1910 | 1,821 | 832,992 |
| 1905 | 803 | 268,676 | 1911 | 1,139 | 407,985 |

[a] The production of tungsten ores in this country from year to year can be fairly compared in this table only since and beginning with 1906, as before that date no effort had been made to reduce the ores to a common basis of concentration. Since 1906 the ores have been, as far as possible, reduced to an equivalent of ore carrying 60 per cent tungsten trioxide ($WO_3$), which is the ordinary commercial basis in the United States.

## PRICES.

During 1911 prices ranged from $4.50 to $8.50 per unit (1 per cent of a short ton, or 20 pounds of tungsten trioxide) for ore carrying 60 per cent or more of tungsten trioxide. For ore carrying less than 60 per cent $WO_3$ less was paid and the price was largely a matter of bargaining over the particular lot.

## WORLD'S PRODUCTION.

Few figures are available to show the production of tungsten in 1911, but those at hand seem to show a general falling off in production.

*The world's production of tungsten ore, 1905–1911, by countries, estimated as far as possible, in short tons of concentrates containing 60 per cent of tungsten trioxide.*

| Country. | 1905 | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 |
|---|---|---|---|---|---|---|---|
| Africa: South Africa | ..... | 9 | 211 | 40 | 16 | (a) | (a) |
| Asia: | | | | | | | |
| Federated Malay States | ..... | 151 | 89 | 83 | 99 | 105 | b 88 |
| French Indo-China | ..... | ..... | ..... | ..... | ..... | c 19 | ..... |
| India | ..... | ..... | ..... | ..... | 7 | d 23 | ..... |
| Japan | 47 | 47 | 71 | 220 | 292 | 275 | e 287 |
| Siam | ..... | ..... | 10 | ..... | ..... | ..... | ..... |
| Australia: | | | | | | | |
| New South Wales | 251 | 270 | 451 | 269 | 431 | 413 | f 482 |
| Northern Territory | 71 | 230 | 177 | 40 | 49 | g 78 | ..... |
| Queensland | 1,582 | 865 | 703 | 516 | 679 | 1,145 | h 750 |
| Tasmania | 36 | 22 | 46 | 5 | 20 | 75 | i 86 |
| Victoria | ..... | ..... | ..... | 3 | 15 | j 31 | ..... |
| Western Australia | ..... | ..... | 1 | ..... | 6 | k 47 | ..... |
| East Indies: | | | | | | | |
| Billiton | ..... | ..... | 4 | 11 | 12 | l 21 | ..... |
| Singkep | ..... | ..... | 1 | 14 | m 12 | l 12 | ..... |
| Europe: | | | | | | | |
| Austria | 65 | 63 | 50 | 44 | 43 | n 54 | ..... |
| England | 193 | 304 | 361 | 261 | 421 | 307 | o 298 |
| France | 28 | 20 | 67 | 124 | 55 | p 33 | ..... |
| German Empire (Saxony) | 42 | 57 | 68 | 46 | q 106 | r 105 | ..... |
| Italy | 36 | 28 | 18 | ..... | ..... | (a) | ..... |
| Portugal | 320 | 629 | 702 | 684 | 609 | s 1,132 | ..... |
| Spain | 413 | 222 | 303 | 249 | t 142 | ..... | ..... |
| Oceania: New Zealand | 64 | 121 | 153 | 87 | 78 | u 187 | ..... |
| North America: | | | | | | | |
| Nova Scotia | ..... | ..... | ..... | ..... | ..... | 83 | (a) |
| United States | 803 | 928 | 1,640 | 671 | 1,619 | 1,821 | 1,139 |
| South America: | | | | | | | |
| Argentina | ..... | 326 | 507 | 548 | 900 | 826 | v 683 |
| Bolivia | 75 | 75 | 500 | 187 | 168 | 232 | w 370 |
| Brazil | ..... | ..... | ..... | 16 | ..... | ..... | ..... |
| Peru | ..... | ..... | ..... | ..... | ..... | ..... | x 13 |
| Total | 4,026 | 4,367 | 6,133 | 4,113 | 5,779 | 7,024 | ..... |

a So far as can be learned, no tungsten ore was produced in South Africa or Italy during 1910, or in Nova Scotia in 1911.

b Min. Jour., London, vol. 97, June 29, 1912, p. 644. Wolframite.

c Carlisle, — — (Consul), Trade and Commerce of French Indo-China for the year 1909: Dipl. and Cons. Repts., London, No. 4596, Ann. Ser. 1910, p. 16. From mines near Caobang, Tonkin.

d Letter from H. H. Hayden, Director Geological Survey of India, Aug. 16, 1911. Wolframite.

e From figures furnished by S. Katsuno, letter dated July 6, 1912. Mr. Katsuno states that the output of scheelite and reinite (ferberite replacing scheelite) averages 35 long tons a year. The remainder of the output is wolframite dressed to 72 per cent $WO_3$.

f Ann. Rep. Dept. Mines New South Wales for 1911, Sydney, 1912, p. 64. As given, the figures were: Scheelite, 108.45 long tons; wolfram, 283.1 long tons. For purposes of conversion to a 60 per cent basis the ores have been considered to carry 70 per cent $WO_3$, which is the content on which prices are based in Australia.

g Letter from Atlee Hunt, Sec. Dept. External Affairs, Commonwealth of Australia, Mar. 4, 1911. Heretofore the figures as given in this table have been credited to "South Australia and Northern Territory," but it is thought that all the tungsten ores have come from Northern Territory, which has been governed by South Australia. Wolframite.

h Australia Mining Standard, Sydney and Melbourne, Apr. 11, 1912, p. 330. The figures as given are: Wolfram, 539.4 long tons; bismuth and wolfram, 129 long tons; and scheelite, 5 long tons. For convenience, the bismuth-wolframite mixture is treated as being half wolframite, as no figures are given to show the exact contents. The output is treated as carrying 70 per cent $WO_3$, the content of tungsten trioxide on which ores are understood to be bought in Australia.

i Progress Min. Ind., Tasmania, Hobart, 1911 and 1912 (quarterly). Wolframite, 69.96 long tons; see note f.

j Letter from I. Cohen for Sec. Mines, Apr. 21, 1911. Wolframite.

## USES.

Tungsten is used chiefly for making steels that will hold their temper when heated. For saw steels 2 or 2½ per cent is used; for high-speed tools for lathes used in working metals a quantity sufficient to make 16 to 20 per cent of tungsten is added. Typical analyses of steels (exclusive of iron content) made by one firm fall within these limits:

| | |
|---|---|
| Carbon | 0.60 to 0.75 |
| Manganese | .15 to .25 |
| Silicon | .15 to .25 |
| Phosphorus | Not above .035 |
| Tungsten | 18.00 to 20.00 |
| Chromium | 4.00 to 5.00 |
| Vanadium | .75 to 1.25 |

These figures show that the steels are really very complicated alloys carrying about 75 per cent of iron.

For finishing tools average analyses of the same maker's steel give, other than iron:

| | |
|---|---|
| Carbon | 1.00 |
| Silicon | 0.35 to .50 |
| Manganese | .25 to .35 |
| Tungsten | 2.00 |
| Sulphur | Not above .025 |
| Phosphorus | Not above .025 |

Tungsten is most generally known as a filament of tungsten incandescent lamps. The great improvements in drawing tungsten wire and further great improvements in the size of the globe and in other mechanical details that add greatly to its efficiency are making the tungsten lamp encroach upon the carbon-filament lamp and the arc lamp, and it is rapidly driving from the market the tantalum lamp, which was the first good metallic-filament incandescent lamp. Diamonds are used for dies in drawing tungsten wire. At first it did not seem possible to drill small enough holes through the diamonds to make wire sufficiently fine for lamps of small candlepower, but wire 0.0006 inch in diameter can now be drawn in quantity. The total quantity of tungsten ore used for electric lights, however, amounts to only a few tons a year.

---

*k* Letter from A. Gibb Maitland, Government geologist, May 26, 1911. Wolframite.

*l* Letter from Nederlandsche Handels-Maatschappij, dated Oct. 27, 1911. The Billiton figures for 1910 are from the end of January, 1910, to the end of January, 1911. The figures for 1910 given for Singkep are from the end of June, 1909, to the end of June, 1910.

*m* Mines and Quarries, Gen. Repts. with Statistics for 1910, pt. 4, Colonial and Foreign Statistics, Home Office, London, 1911, p. 386.

*n* Statistik des Bergbaues in Österreich für 1910, No. 1, Vienna, 1911, p. 105.

*o* Mines and Quarries, etc., 1911, pt. 1, 1912, p. 10. Wolframite.

*p* Statistique de l'industrie minérale et des appareils à vapeur en France et en Algérie pour l'année 1909, p. 32. Wolframite.

*q* Jahrbuch für das Berg- und Hüttenwesen im Königreiche Sachsen, Jahrgang 1910, Freiberg, 1910, p. B65. Wolframite.

*r* Min. Jour., London, vol. 95, Nov. 25, 1911, p. 1140. Wolframite.

*s* Figures received from the Ministerio do Fomento, September, 1911, following a letter of previous date. The figures as given were: Wolfram, 947.5 toneladas, 65 per cent $WO_3$.

*t* Estadística minera de España, año 1909, Madrid, 1911, pp. 22–23. Wolframite.

*u* Letter from H. I. H. Blow, Under-Sec., Mines Dept., New Zealand, Feb. 20, 1911. Exports of scheelite. The figures given were 143 long tons. The ore is thought to have run about 70 per cent $WO_3$.

*v* Letter, E. Hermitte, Dirección General de Minas, dated June 17, 1912. "Esta exportación durante los años 1910 y 1911 ha sido la siguente: Calculado en $WO_3$—Tungsteno año 1910, 449,312 kilograms, valor $271,130.62 0/5; tungsteno año 1911, 371,901 kilograms, valor $251,033 74 0/5." Wolframite.

*w* Communicated by the Pan American Union, July 10, 1912. The figures as given were 144,368 kilos, presumably of about 70 per cent $WO_3$ for the first six months of 1911. The year is estimated at twice as much. Wolframite.

*x* Min. and Eng. World, Chicago, vol. 37, July 27, 1912, p. 156. Stated as 12 metric tons. Per cent $WO_3$ not given.

In a very general way ductile tungsten is made as follows: The carefully purified tungsten trioxide is reduced to metallic tungsten by passing pure hydrogen over the heated oxide. The resulting metal is in a fine powder, which is squeezed under a hydraulic press into a stick strong enough to stand careful handling. This stick is then heated to a very high temperature in a fuel-using furnace and later further sintered by heating under an electric current. It is then hammered, rolled, punched, or drawn into the forms desired.

New uses of tungsten, in making electric furnaces, electric contacts, and targets for Roentgen rays, have been developed, and the last two are being actively manufactured. For electric furnace work molybdenum is said to be superior to tungsten.

Concerning these new uses W. D. Coolidge says:[1]

> The tungsten or molybdenum-wound furnace * * * has proved to be an exceedingly useful tool, especially so in connection with the production of wrought tungsten and molybdenum. Extensive factory use has shown it to be not only cheaper but, regardless of cost, far superior to a platinum-wound electric furnace. When wound on a body of alundum it permits the attainment of higher temperature than can be reached with platinum. This attainment of the higher temperature is often in itself an advantage, and it is always an advantage, in industrial work, to be relieved from the necessity of using the strictest temperature control to avoid melting a furnace winding. This is especially true in cases where the time consumed in heating up the work in the furnace is important, for in these cases much time is saved by not using a constant current supply to the furnace winding but by first raising the current, upon the introduction of the cold work, and then bringing it down as the temperature of the work rises.

These furnaces must be used in an atmosphere of hydrogen to prevent oxidation.

### ELECTRICAL CONTACTS OF TUNGSTEN AND MOLYBDENUM.

Tungsten and molybdenum are destined to play a very important rôle in the field of contact-making devices. This is due to their high melting point, which prevents them from welding together; to their heat conductivity (about twice that of platinum), which tends to keep down local temperature rise; and to their hardness, which enables them to stand repeated impact without flattening out.

The natural assumption would be that both metals under the heat of even minute arcs, which form when the contacts are separated, would oxidize at the points where arcing has taken place and that nonconducting layers would thus be formed which would produce a high and variable contact resistance. But several things intervene to prevent this. First, there is the relatively good heat conductivity of the dense form of these metals, which distributes the heat. Then the fact that the metals are much less expensive than platinum, for example, makes possible the use of larger contact masses, which again militates against strong local heating. Finally, there is the fact that with both tungsten and molybdenum the oxides which form in the presence of a sufficiently limited amount of oxygen are conducting.

Some promising applications which are being tested out are the following:

As an iridium substitute in the "master" contacts of Tirrell voltage regulators.

As a silver substitute in the relay contacts of Tirrell voltage regulators.

As an iridium substitute in feed-wire voltage regulators.

As a platinum substitute in railway signal relays.

As a substitute for platinum-iridium in the contacts of a synchronously driven vibrating mechanical rectifier.

As a platinum substitute in telephone jacks.

As a platinum substitute in automobile and stationary gas-engine ignition work, for spark coil contacts, magneto circuit-breaker contacts, and spark plugs.

In connection with the above there was at first serious difficulty in getting satisfactory heat contact between tungsten or molybdenum on the one hand and iron or brass, as the case might be, on the other. This was due to the fact that neither tungsten nor molybdenum can be satisfactorily soldered by any of the ordinary processes. This difficulty has been finally entirely overcome.

[1] Coolidge, W. D., Some applications of wrought tungsten and molybdenum: Jour. Indust. and Eng. Chem., vol. 4, January, 1912, pp. 2–4.

## TUNGSTEN AS TARGET IN A RÖNTGEN (X-RAY) TUBE.

This has proved to be, both from the scientific and practical points of view, an exceptionally interesting application.

Until recently platinum has been almost universally regarded as the best target material, and it has so long held undisputed sway in this field that the Röntgen ray worker has come to look upon its limitations as inherent in the Röntgen tube.

It has not been possible until recently to produce dense, forged pieces of pure malleable tungsten, but with the advent of this material the possibilities of the Röntgen tube are greatly extended.

The desiderata in a material to be used as the anticathode, or target, are the following:

1. High specific gravity.
2. High melting point.
3. High heat conductivity.
4. Low vapor pressure at high temperature.

The reasons why the above qualities are desirable follow readily from a brief consideration of the theory of Röntgen-ray production.

From the concave cathode electrically charged particles, the electrons, are shot out at high velocity in a direction normal to the surface. The paths of these particles converge and the target is placed at or near the point of strongest convergence—the focus point. When the electron meets an obstruction, as the target, its velocity is reduced, and the denser the target the more rapid is the deceleration. The more rapid the deceleration the greater is the amplitude of the electromagnetic pulse, the Röntgen ray, sent out. Here, then, is a need for high specific gravity; that of forged tungsten is but little less than that of platinum.

In modern Röntgen-ray practice powerful apparatus, running sometimes to a capacity of six kilowatts, is used to excite the tube. The greater part of the energy delivered to the tube is transformed into heat at the point where the cathode rays bombard the target. Where platinum is used, it has been found necessary, to prevent melting, to place the target beyond the focus of the cathode so as to spread the bombardment over a larger area. As a radiograph is a shadow picture, and as the source of the Röntgen-ray is the bombarded area of the target, this enlarging of that area is clearly an undesirable thing to do, as the larger area will mean more overlapping and less definition in the resulting picture. In this way the melting point of platinum has been the limiting feature of the Röntgen tube. The capacity of the tube has been increased by water cooling the platinum or by using as a target a large mass of copper having a very thin platinum face. But the limit, although raised by this artifice, has still been the melting point of the platinum.

Tungsten has a much higher melting point (3,000° C., as against 1,755° for platinum), and so, even with sharp focusing of the cathode rays on the target, permits the use of more energy than has hitherto been possible, for the high temperature to which it can run enables it to radiate more heat and its better heat conductivity permits a more rapid flow of heat from the focus spot to the surrounding metal.

Stability of vacuum in a Röntgen tube is of the utmost importance, as the character of the rays is so largely determined by the vacuum. Metal which under the influence of the high temperature vaporizes from the target condenses on the glass in finely divided form and absorbs relatively large amounts of gas, thus changing the vacuum. At high temperatures tungsten vaporizes least of all the metals.

In the above case practice seems to be in full accord with the theory, and the tungsten target offers great promise to the Röntgen-ray worker. It gives him what he has not had before—an indestructible target—so far as the present electrical apparatus goes, together with sharper definition and much shorter exposure.

## TUNGSTEN PROJECTILES.

The use of wrought tungsten as a projectile is being carefully investigated. It offers in this field possibilities not possessed by any other metal.

The present small-arm service projectile is made of lead with a jacket of copper-nickel alloy. The principal advantage of lead over iron, which would of course be cheaper, is that it has a higher specific gravity. Because of this fact a lead bullet will have a smaller cross-section, and will therefore encounter less air resistance to its flight than will an iron bullet of the same weight, and will therefore give a flatter trajectory and longer range. An iron bullet of the same diameter as the lead bullet could of course be given the same weight by increasing its length, but this would at once necessitate giving it a higher rotational velocity to keep its axis tangential to its flight. To impart this added rotational velocity calls for the expenditure of energy

and so leaves less for velocity of translation. The lead bullet, then, with its higher density, makes possible a flatter trajectory and longer range. With the exception of tungsten, lead is the densest metal which can be considered for this purpose, for gold is the cheapest of the other elements having a higher specific gravity than lead. The density of wrought tungsten is 19.3, while that of lead is 11.5.

For military purposes the softness of lead is not an advantage, a soft-nosed bullet being tabooed in civilized warfare. For this reason and because of the fact that it is too weak to hold the rifling it has to be jacketed with the copper-nickel alloy. To take the rifling and to act as a gas check, the tungsten bullet will require a copper band or its equivalent at the base.

The hardness and high tensile strength of wrought tungsten will give high penetrating power.

The high melting point of tungsten will prevent it from being harmfully upset at the base by the combined action of the high temperature and rapid impact due to the combustion of the powder charge. (An unsymmetrical upsetting of the base of a projectile is very prejudicial to accuracy.)

It would be a very simple matter to calculate the constants of the trajectory of a tungsten projectile were it not for the fact that the high density removes it too far from the present base line. For such calculations one quantity is lacking—the so-called "form factor." This factor could itself be calculated if it contained, as the name would seem to imply, only the dimensions and the specific gravity; but there are also involved in it all of the errors due to simplifying assumptions which have been made in connection with the mathematical derivation of formulæ. It therefore becomes necessary to experimentally determine the constants of the trajectory of tungsten bullets, and preparations for this work are now being made.

Most of the tungsten ore mined in this country was reduced to tungsten or to ferrotungsten, but ores, tungsten, and ferrotungsten, were also imported.

## IMPORTS.

During 1911, according to the Bureau of Statistics, "tungsten or wolfram metal and ferrotungsten" to the extent of 115.52 tons, valued at $143,802, were imported.

Tungsten-bearing ores, of which the quantity was not stated, were imported during the first half of the year to the value of $63,621, and during the second half 50 tons, valued at $22,266.

# VANADIUM.

By Frank L. Hess.

## CONDITION OF THE INDUSTRY.

Though the use of vanadium undoubtedly increased during 1911 the production apparently increased even more rapidly, so that there was a general letting down of prices. The known facts about the uses of vanadium seem to point to a growing demand, and the dullness of the steel trade probably had as noticeable influence upon the price of vanadium as it had upon tungsten. During the year there was much prospecting of vanadiferous deposits and an active search for productive properties.

*Arizona.*—Discoveries of vanadinite were reported from the vicinity of Florence and Patagonia, but no production is known to have been made in the State.

*Colorado.*—Production was confined to San Miguel and Montrose counties.

In San Miguel County the Primos Chemical Co. operated its mines on Bear Creek, 2½ miles south of Newmire, throughout the year. The company extracts the vanadium from the ore as a chloride and precipitates it as iron vanadate, which is shipped east for reduction to ferrovanadium.

On Fall Creek W. H. Pletcher and associates and the General Vanadium Co. mined roscoelite ore which was considerably stained with carnotite. Claims were worked at a number of places along the north side of San Miguel River between Sawpit and Placerville and along both sides of Leopard Creek between Placerville and Brown, a distance of 7 miles. All the vanadium ore of the district is made up of a sandstone impregnated with roscoelite, generally lying on one or both sides of a thin horizontal parting in the sandstone which in many places is occupied by a vein less than an inch thick of roscoelite and a little quartz and which in places carries more than 8 per cent of vanadium. To be of shipping grade the rock must carry about 3 per cent vanadium, and the material must be carefully selected to give so high a grade, for the percentage of vanadium in most of the vanadiferous sandstones is considerably lower, and there are only spots that will furnish the high-grade ore in sufficient quantity to pay for shipment. Most of the vanadium-bearing rock probably carries less than 1 per cent vanadium and if made to pay for mining must be treated on the ground.

In places carnotite occurs in small quantity with the ore, but uranium is so difficult to separate from vanadium that its presence adds little if anything to the value of the ore.

Considerable ore containing carnotite (a complex variable uranium and vanadium mineral) was mined and shipped from Paradox Valley, Montrose County. The General Vanadium Co. and the Standard Chemical Co. were the principal operators, and they bought practically all the ore shipped from the region which they did not themselves mine.

With the carnotite is a red calcium vanadate which, however, does not occur in very large quantity. There is also a blue-black vanadium mineral of uncertain composition. The ores occur not only in the Paradox Valley but along the lower course of San Miguel River and farther south, on the east side of Rio Dolores, below Disappointment Creek, in the vicinity of Cedar. No ore is known to have been mined in 1911 in the "Disappointment country," as the area through which the creek flows is generally known, but some prospecting and development work was done.

The ore mined and bought by the General Vanadium Co. was shipped via Galveston, Tex., to Liverpool, England, for treatment. That of the Standard Chemical Co. was treated at Canonsburg, Pa. The ore from Paradox Valley and adjacent territory is shipped through Placerville after a long uphill haul of 50 miles or more.

The total production of ores shipped and reduced in San Miguel and Montrose counties, which is the whole Colorado production for the year, amounted to 8,400 tons, valued at $302,000. Other deposits of carnotite occur on Coal Creek, northeast of Meeker, Rio Blanco County, and on Blue Mountain (Skull Creek) in Moffat County, 15 miles north of Rangely. Some prospecting was done on these deposits during the year, but no production was made.

*New Mexico.*—Some work was done in the Sierra de los Caballos, near Cutter, Sierra County, during the year, but no production of vanadium ore is known to have been made. Vanadium occurs here in the form of vanadinite in fine acicular crystals with other lead minerals, copper minerals, barite, and calcite in veins following crushed zones in limestone.

A small production of vanadium ore was sold as such from the Lucky Bill mine near Bayard station. Specimens of the ore sent to the United States Geological Survey are yellow with green blotches and are peculiarly massive. In microscopic section the rock is seen to be made up of vanadinite crystals in quartz, which apparently replaces a brecciated porphyritic rock. The green color is probably due to descloizite.

Considerable prospecting was done on vanadinite and associated minerals near Magdalena, Silver City, and Hillsboro, but no production was reported.

*Utah.*—Two shipments of carnotite-bearing ore were made in 1911 from deposits on the east side of the San Rafael Swell, 15 miles west of Greenriver. The ore in one shipment carried 3.87 per cent of $V_2O_5$ and 2.24 per cent $U_3O_8$. Though figures are not at hand for the second shipment, it is thought to have carried about the same percentages of vanadium and uranium as the first shipment. Farther south along the San Rafael Swell considerable development work was done on claims in Wildhorse Canyon. Here carnotite is associated with asphalt and calcium vanadate in sandstone. A shipment of carnotite from near Richardson was made early in the year and another small shipment of carnotite was later made from

Professor Valley, north of the La Sal Mountains. Both shipments carried a larger percentage of uranium than the ore from the San Rafael Swell, but less vanadium. There has been much prospect- through the eastern part of Utah, especially south of the Denver & Rio Grande Railroad and east of Green River, in the La Sal Mountains and northward.

In Uinta County deposits of carnotite are reported to occur with copper minerals on both sides of Green River in Split Mountain Canyon and within a radius of 15 miles around Independence, extending into Carbon County on the west.

A ton of supposed carnotite-bearing ore is reported to have been shipped for a milling test from Pahreah in Kane County, but no further details have been given.

The ores shipped from New Mexico and Utah, which are combined so as to prevent disclosing individual outputs, amounted to about 65 or 70 tons, valued at about $3,500.

## IMPORTS.

A considerable quantity of vanadium sulphide (patronite) ore from Minas Ragras, near Cerro de Pasco, Peru, is known to have been imported during the year, and possibly some vanadinite from other countries, but the quantities and values are unknown.

## USES.

The use of vanadium is almost wholly in alloy steels, for tools, automobile and engine parts, gears, and other steels in which great hardness or toughness is desired. Generalized analyses of tool steels containing vanadium are given under "Tungsten." Like other alloy steels, those in which vanadium is used are complicated, and the exact relation of properties to ingredients is often difficult to determine. In steels to which vanadium is added to produce toughness the problem is apparently more simple, and the value of vanadium, which is used as a deoxidizer and denitrogenizer, seems to be well established.

Vanadium has been used in making bearing metal and in bronzes.

Small quantities of vanadium are used in dyeing and in medicine.

# URANIUM.

By Frank L. Hess.

Except as incidentally taken out in mining carnotite for vanadium, very little uranium was mined in the United States in 1911. A few hundred pounds of pitchblende was mined from the German mine by the German Gold & Uranium Mining Co., at Central City, Gilpin County, Colo. This material was not sold during the year, but is said to have been used by the company in experimental work. The company also owns the Belcher mine, which has produced some pitchblende.

The German and Belcher veins are two of a group of parallel veins which carry pitchblende in pockets and small seams associated with sphalerite, pyrite, galena, gold, and silver. In the group are also the Wood, Kirk, Alps, and Calhoun veins, which have produced more or less pitchblende from time to time. The Kirk has probably been the largest producer, though figures have been refused.

In North Carolina a few hundred pounds of pitchblende, part of which is altered to gummite and other oxidation products, has been saved in mining feldspar at Penland, N. C.

By far the larger part of the uranium mined in the country, however, is that contained in carnotite mined for vanadium. The uranium in ores so mined in 1911 amounted to about 25 short tons of $U_3O_8$, or 21.2 tons of metallic uranium. As nearly as can be ascertained, half of this quantity was shipped abroad in the form of ore. The popular interest in uranium is due almost wholly to its connection with radium, the properties of which appear so marvelous when compared with more familiar materials. Radium extraction has been attempted in the United States by several persons and firms. Some of these have given up their efforts, but others are still at work, with what success is unknown.

The uses of uranium and its compounds are comparatively few and not extensive. It is used principally for making yellow glass, for yellow glazes on pottery, and in a less degree as a chemical reagent. Yellow glass made with uranium oxide is known as "opalescent." Direct light gives a yellow color and indirect light a greenish yellow. It is an expensive glass, as much as 20 per cent $U_3O_8$ being used to get the color used in incandescent electric-light bulbs. Such glass is radioactive to a considerable degree. By the addition of other substances the color may, of course, be modified.

The attempt to use uranium in steel has been given up by certain firms who have experimented with it, the claim being made that it

apparently imparts about the same properties as tungsten and is very much more expensive. Others, however, appear to be still pursuing such experiments.

*Imports.*—According to the Bureau of Statistics, oxide and salts of uranium to the value of $10,176 were imported in 1910, and to the value of $14,106 in 1911. This is one of the comparatively few mineral products of which the United States ships the raw material abroad to be imported in manufactured form.

# TITANIUM.

By Frank L. Hess.

No rutile is known to have been produced in the United States in 1911. The American Rutile Co. did not operate its property or plant at Roseland, Nelson County, Va., but filled orders from its accumulated stock.

From the data at hand, most of the ferrotitanium manufactured seems to be made from titaniferous magnetite or from ilmenite. It is probable that much more consistent results can be obtained in making ferrotitanium with rutile than with ilmenite, owing to the easier control of the percentages of titanium and iron, but ilmenite and titaniferous magnetite are much cheaper than rutile. Ilmenite is not suitable, however, for making titanium carbide used in electrodes for arc lamps, and there promises to be some demand for this purpose.

From figures published on page 73 of the Annual Statistical Report for 1911 of the American Iron and Steel Association, 152,990 long tons of steel rails were treated with titanium in 1911 against 256,759 tons in 1910. Other alloy rails treated with manganese, nickel, chromium, or vanadium, amounted to 999 tons against 565 tons in 1910. None weighed less than 45 pounds per yard.

A small quantity of rutile was exported to Europe.

*Imports.*—Ferrotitanium to the amount of 51.17 tons and valued at $22,700 was imported for consumption in 1911.

# MOLYBDENUM.

By Frank L. Hess.

No commercial production of molybdenum is known to have been made in the United States during 1911. About 60 tons of rock carrying molybdenite is said to have been mined in the Ten Mile district, Summit County, Colo., and shipped to Denver for concentration, but the material was too poor to pay for treatment.

Some further work was reported as having been done upon the Catherines Hill deposits near Cherryfield, Me., but it was developmental and experimental, and there was no commercial production of molybdenite.

So far as can be learned by the United States Geological Survey, the use of molybdenum in steel making is not increasing. Some other uses are being developed, particularly the use in making small electric furnaces, for which it is said to be the best substance yet employed. Some of the tungsten filaments used in electric lamps are supported at the lower end by molybdenum wire.

As ordinarily made, molybdenum is a bluish-black powder with a melting point so high that it can not be directly melted into a mass, but by proper treatment, similar to that given tungsten (see p. 8), it may be made into a wire which is tougher and stands much rougher usage than tungsten wire.

Magnet steels are being made which contain about 6 per cent molybdenum.

*Imports.*—Molybdenum and ferromolybdenum valued at more than $200 a ton were imported in 1911 to the amount of 8.5 tons, valued at $11,409.

# NICKEL.

By Frank L. Hess.

## CONDITIONS.

No production of nickel ore, as such, in the United States during 1911 was reported to the United States Geological Survey, but salts and metallic nickel equivalent to 445 tons of metallic nickel, valued at about $127,000, were saved as by-products. The nickel was largely saved from the electrolytes of the copper refineries. Much of the copper refined electrolytically contains some nickel as an impurity which passes into the electrolyte, in which, if allowed to accumulate beyond 1 per cent, it is said to be harmful to the proper deposition of the copper. The crude copper from which the nickel is obtained is of both domestic and foreign origin, and the portion derived from either source is unknown. The salts are used in nickel plating.

All other nickel used in the United States comes from Sudbury, Canada. Concerning the industry at that place, John McLeish [1] states:

> The mining and smelting of nickel-copper ores in the Sudbury district of Ontario was carried on actively throughout the year and although the production was slightly less than in 1910 it was still very much larger than in any previous year. Active operations were as usual carried on by the Mond Nickel Co. at Victoria Mines and the Canadian Copper Co. at Copper Cliff, Creighton, Crean Hill, etc., while the Dominion Nickel Co. continued to develop their property at Norman Station.
>
> The ore is first roasted and then smelted and converted to a Bessemer matte containing from 77 to 82 per cent of the combined metals, copper and nickel, the matte being shipped to the United States and Great Britain for refining. A portion of the matte is now used for the production of the alloy monel metal which is obtained directly from the matte without the intermediate refining of either nickel or copper.
>
> The total production of matte in 1911 was 32,607 tons, valued at the smelters at $4,945,593, a decrease of 2,426 tons, or 6.9 per cent, from the production of 1910. The metallic contents were copper 17,932,263 pounds, and nickel, 34,098,744 pounds.
>
> The aggregate results of the operations on the Sudbury district nickel-copper ores during the past two years were as follows, in tons of 2,000 pounds:

| | 1910 | 1911 |
|---|---|---|
| | *Short tons.* | *Short tons.* |
| Ore mined | 652,392 | 612,511 |
| Ore smelted | 628,947 | 610,834 |
| Bessemer matte produced | 35,033 | 32,607 |
| Copper contents of matte | 9,630 | 8,966 |
| Nickel contents of matte | 18,625 | 17,049 |
| Spot value of matte shipped | $5,380,064 | $4,945,592 |
| | *Pounds.* | *Pounds.* |
| Exports to Great Britain | 5,335,331 | 5,023,393 |
| Exports to United States | 30,679,451 | 27,596,578 |
| Total | 36,014,782 | 32,619,971 |

[1] Preliminary report on the mineral production of Canada during the calendar year 1911, Ottawa, 1912, p. 13.

The Canadian Copper Co. is that subsidiary of the International Nickel Co. which mines the ore and smelts it to a matte and to oxide. The Orford Copper Co. is a second subsidiary company, which takes the matte and oxide and extracts the metals. Although shipped here not all the matte and oxide is refined in this country. Some is shipped to Europe. Besides refined nickel and monel metal the Orford Copper Co. also produces considerable quantities of nickel sulphate and nickel-ammonium sulphate for use in the nickel-plating trade. The Mond Nickel Co. ships its matte to Swansea, Wales, for refining. The Sudbury ores are entirely sulphides, mostly nickeliferous pyrrhotite, and carry considerable chalcopyrite. The largest of the other nickel deposits are those of Noumea, New Caledonia, in the southern Pacific Ocean. The ores are silicates and all go to France, none now coming to this country.

The price of refined nickel was quoted up to May, 1911, as 40 to 45 cents a pound, and during the remainder of the year the quotations were 40 to 50 cents a pound in large lots. Electrolytically refined nickel was quoted at 5 cents higher a pound.

The use of nickel is apparently growing, especially in steel and in nickel plating. The use of the recently introduced alloy known as monel metal seems to be also growing. This alloy is produced by smelting the nickel copper ore mined at Sudbury, Ontario, with no attempt to separate the copper from the nickel. The smelting process is thus made much shorter and cheaper, and the alloy can be sold at a lower price than pure nickel.

For some purposes it is said to be better than any known metal, as it corrodes less easily than brass or bronze, and in strength compares well with steel. It may be cast by adding proper deoxidizing agents. For valves to be used under high steam pressure, where bronze is said to soften and give way, monel metal does well. In propeller blades requiring great strength and resistance to corrosion, for roofing, in sulphuric-acid pumps, and in many other trying positions, it is reported to behave excellently.

## IMPORTS.

The imports of nickel for consumption into the United States from 1906 to 1911, inclusive, as reported by the Bureau of Statistics, have been as follows:

*Imports of nickel for consumption into the United States, 1906–1911, in pounds.*

| | Nickel, nickel ore, and matte, nickel oxide, alloys of nickel with copper, etc.[a] | | Value of manufactured articles of nickel. | Total value. |
|---|---|---|---|---|
| | Quantity. | Value. | | |
| 1906 | 34,082,042 | $1,867,568 | $8,963 | $1,876,531 |
| 1907 | 18,598,638 | 2,233,867 | 9,159 | 2,243,026 |
| 1908 | 16,825,291 | 2,487,605 | 9,980 | 2,497,585 |
| 1909 | 22,194,102 | 3,034,407 | 1,866 | 3,036,273 |
| 1910 | 32,373,251 | 4,213,079 | 14,759 | 4,227,838 |
| 1911 | 29,829,268 | 4,022,716 | 27,314 | 4,050,030 |

[a] Includes only the nickel content of ore and matte. No ore is known to have been imported into the United States in 1911.

The imports for 1911 were divided as follows:

*Imports of nickel for consumption into the United States in 1911, in pounds.*

| | Quantity. | Value. |
|---|---|---|
| Nickel, alloys, pigs, bars, etc | 291,957 | $103,717 |
| Ore and matte, nickel content (gross weight 23,896 tons) | 29,535,967 | 3,918,556 |
| Sheets or strips and manufactured articles | ..... | 27,314 |
| Nickel oxide | 1,344 | 443 |
| Total | 29,829,268 | 4,050,030 |

## EXPORTS.

The United States refines much more nickel than it can use, so that although not an important producer it is a large exporter. Exports since 1901 have been as follows:

*Exports of nickel, nickel oxide, and matte from the United States, 1901–1911, in pounds.*

| Years. | Quantity. | Value. | Years. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1901 | 5,869,655 | $1,521,291 | 1907 | 8,772,578 | $2,845,663 |
| 1902 | 3,228,607 | 924,579 | 1908 | 9,770,248 | 3,297,988 |
| 1903 | 2,414,499 | 703,550 | 1909 | 12,048,737 | 4,101,976 |
| 1904 | 7,519,206 | 2,130,933 | 1910 | 15,244,937 | 4,704,088 |
| 1905 | 9,550,918 | 2,894,700 | 1911 | [a]25,099,586 | 8,283,777 |
| 1906 | 10,620,410 | 3,493,643 | | | |

[a] No nickel matte is known to have been exported during 1911.

# COBALT.

By Frank L. Hess.

No cobalt was produced in the United States in 1911, although it seems probable that, with an active demand, the concentrates saved in extracting lead ores at Fredericktown and at Mine La Motte, Mo., might be made profitably productive, and likewise deposits near Blackbird, Idaho, when transportation facilities are improved.

The great producing locality is now Cobalt, Ontario. The supply for the United States is said to come wholly from Cobalt. Cobalt ores are shipped to England and the oxide sent to this country. Cobalt ores from which cobalt oxide is made are also treated by the Orford Copper Co., at Constable Hook, N. Y.

The alloy stellite, composed of cobalt and chromium, invented by Mr. Elwood Haynes, of Kokomo, Ind., was not manufactured on a large scale during the year, although some knives with stellite blades were placed on the market. The use of cobalt in making stellite for knives and utensils seems to hold the most promising outlook for the metal.

The imports for consumption of cobalt into the United States since 1901 have been as follows:

*Cobalt oxide, ore, and zaffer imported into the United States for consumption, 1901–1911, in pounds.*

| Years. | Quantity. | Value. | Years. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1901 | 71,969 | $134,208 | 1907 | 48,013 | $74,849 |
| 1902 | 79,984 | 151,115 | 1908 | 219,098 | 17,077 |
| 1903 | 73,350 | 145,264 | 1909 | 12,132 | 11,696 |
| 1904 | 42,354 | 86,925 | 1910 | 14,935 | 6,352 |
| 1905 | 70,048 | 139,377 | 1911 | 579,520 | 48,104 |
| 1906 | 41,084 | 83,167 | | | |

# TANTALUM.

By Frank L. Hess.

The one use which has brought tantalum into great prominence has been the making of filaments for incandescent electric lamps. The first successful metallic filament lamps were made from it and, owing to the toughness of the wire, for a while it seemed likely that it would remain a valuable material for the purpose, for although its efficiency was lower than that of the tungsten lamps (about 2 watts per candlepower for tantalum, as against 1.1 for tungsten) the first tungsten filaments were so brittle as to make their carriage precarious. During the last two years the processes by which tungsten wire can be drawn have been so far developed that tantalum lamps can now show little advantage in toughness and they are largely being driven from the market.

How far the making of surgical and dental instruments, pens, and other small instruments of tantalum can be carried is uncertain. No recent prices have been obtained upon tantalum in mass; but for a while it was held at about the same price as gold, which is prohibitive for many uses. For instance, although it makes an excellent pen, it makes a very costly one, and, in the limited experience of the writer, unless the user can put a new point on his pen or get it done, the pen is altogether too costly, as the tantalum pen wears much faster than a gold pen. By regrinding the point the writer has made a poorly designed pen very satisfactory. As wire for incandescent lamps, tantalum sells for nearly $500 an avoirdupois pound.

It appears that Von Bolton,[1] in his original experiments, was mistaken in the hardness of tantalum. It was stated that owing to its hardness a thin plate of tantalum could not be drilled through by a diamond-pointed drill. It is reported that the real reason the tantalum was not pierced by the diamond was not because of the hardness of the tantalum, but because of flowage in the metal.

No tantalum minerals are known to have been produced in this country during 1911 except a few hundred pounds of columbite, produced by Emil E. Hesnard, Custer, S. Dak., which was sold for mineralogical specimens.

*Imports.*—A considerable quantity of tantalum wire was imported from Siemens & Halske, A. G., Berlin, Germany, during the year, for making incandescent lamps, but the quantity and value may not be given.

[1] Von Bolton, W., and Feuerlein, O., Die Tantallampe, eine neue Glühlampe der firma Siemens & Halske, A. G.: Electrotech. Zeitschr., Berlin, Jan. 26, 1905, pp. 107–109. A digest translation of the article is given in Mineral Resources of the United States for 1906, pp. 532–534.

## UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS ON RARE METALS.

The following articles on rare metals have been published by the United States Geological Survey. Those that are out of stock for free distribution can be obtained from the Superintendent of Documents, Washington, D. C., for the price indicated.

### TUNGSTEN.


Bancroft, Howland, Notes on tungsten deposits near Deer Park, Wash.: Bull. U. S. Geol. Survey No. 430, 1910, pp. 214–216.

Brooks, A. H., Geologic features of Alaskan metalliferous lodes: Bull. U. S. Geol. Survey No. 480, 1911, pp. 88–90.

Hess, Frank L., Note on a tungsten-bearing vein near Raymond, Cal.: Bull. U. S. Geol. Survey No. 340, 1908, p. 271. 30 cents.

——— Tin, tungsten, and tantalum deposits of South Dakota: Bull. U. S Geol. Survey No. 380, 1909, pp. 131–163.

——— Note on a wolframite deposit in the Whetstone Mountains, Arizona: Bull. U. S. Geol. Survey No. 380, 1909, pp. 164–165.

——— Tungsten: Mineral Resources U. S. for 1908, pt. 1, U. S. Geol. Survey, 1909, pp.721–731. 60 cents.

Hill, J. M., Note on the occurrence of tungsten minerals near Calabasas, Ariz.: Bull. U. S. Geol. Survey No. 430, 1910, pp. 164–166.

Hobbs, W. H., The old tungsten mine at Trumbull, Conn.: Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 2, 1901, pp. 13–22.

——— Tungsten mining at Trumbull, Conn.: Bull. U. S. Geol. Survey No. 213, 1903, p. 98. 25 cents.

Johnson, B. L., Occurrence of wolframite and cassiterite in the gold placers of Deadwood Creek, Birch Creek district [Alaska]: Bull. U. S. Geol. Survey No. 442, 1910, pp. 246–250. 40 cents.

Weeks, F. B., Tungsten ore in eastern Nevada: Bull. U. S. Geol. Survey No. 213, 1903, p. 103. 25 cents.

——— Tungsten deposits in the Snake Range, White Pine County, eastern Nevada: Bull. U. S. Geol. Survey No. 340, 1908, pp. 263–270. 30 cents.


### VANADIUM AND URANIUM.


Boutwell, J. M., Vanadium and uranium in southeastern Utah: Bull. U. S. Geol. Survey No. 260, 1905, pp. 200–210. 40 cents.

Gale, H. S., Carnotite in Rio Blanco County, Colo.: Bull. U. S. Geol. Survey No. 315, 1907, pp. 110–117. 50 cents.

——— Carnotite and associated minerals in western Routt County, Colo.: Bull. U. S. Geol. Survey No. 340, 1908, pp. 257–262. 30 cents.

Hess, Frank L., Uranium: Mineral Resources U. S. for 1908, pt. 1, U. S. Geol. Survey, 1909, pp. 747–748. 60 cents.

——— Vanadium: Mineral Resources U. S. for 1908, pt. 1, U. S. Geol. Survey, 1909, pp. 741–742. 60 cents.

Hillebrand, W. F., On the occurrence of nitrogen in uraninite, and on the composition of uraninite in general: Bull. U. S. Geol. Survey No. 78, 1891, pp. 43–79. Out of stock.

——— and Ransome, F. L., On carnotite and associated vanadiferous minerals in western Colorado: Bull. U. S. Geol. Survey No. 262, 1905, pp. 9–31.


### TITANIUM.


Hess, Frank L., Titanium: Mineral Resources U. S. for 1908, pt. 1, U. S. Geol. Survey, 1909, pp. 742–745. 60 cents.

Watson, T. L., and Taber, Stephen, The Virginia rutile deposits: Bull. U. S. Geol. Survey No. 430, 1910, pp. 200–213.

MOLYBDENUM.

HESS, FRANK L., Some molybdenum deposits of Maine, Utah, and California: Bull. U. S. Geol. Survey No. 340, 1908, pp. 231–240. 30 cents.

——— Molybdenum: Mineral Resources U. S. for 1908, pt. 1, U. S. Geol. Survey, 1909, pp. 745–747. 60 cents.

SCHRADER, F. C., and HILL, J. M., Some occurrences of molybdenite in the Santa Rita and Patagonia Mountains, Arizona: Bull. U. S. Geol. Survey No. 430, 1910, pp. 154–164.

SMITH, G. O., A molybdenite deposit in eastern Maine: Bull. U. S. Geol. Survey No. 260, 1905, pp. 197–199. 40 cents.

NICKEL AND COBALT.

HESS, FRANK L., Nickel, cobalt: Mineral Resources U. S. for 1908, pt. 1, U. S. Geol. Survey, 1909, pp. 736–741. 60 cents.

KAY, G. F., Nickel deposits of Nickel Mountain, Oregon: Bull. U. S. Geol. Survey No. 315, 1907, pp. 120–127. 50 cents.

TANTALUM.

HESS, FRANK L., Tin, tungsten, and tantalum deposits of South Dakota: Bull. U. S. Geol. Survey No. 380, 1909, pp. 131–163.

——— Mineral Resources U. S. for 1908, pt. 1, U. S. Geol. Survey, 1909, pp. 748–749. 60 cents.

# TIN.

By Frank L. Hess.

## NEED OF A DOMESTIC SUPPLY.

The peculiar deficiency of the United States in tin deposits and the great quantity of tin used in the country, amounting to between 40 and 50 per cent of the world's production, make the possible domestic sources of supply a subject of perennial interest. Many letters are received by the United States Geological Survey asking where tin deposits can be found in the United States, and to supply this demand for information a brief outline of the occurrences of the metal will be given in this paper.

For some unknown reason, there is a widely prevalent idea that the United States offers a reward for the discovery of a tin mine that can be worked at a profit. Many letters are received each year asking about this supposed reward. Where the rumor started is unknown, but it seems to be fostered by unscrupulous or ignorant persons who have mining stock to sell. It may be well to state here that the United States does not offer and so far as is known to the Survey never has offered a reward for the discovery of a tin mine, or any other mine.

## PRODUCTION.

In 1911 the output of tin ore in Alaska was equivalent to 61 tons of metallic tin, valued at $52,409. From Buck Creek, Alaska, 92 tons of stream tin, carrying 66 per cent of tin, was dredged, and 1,200 pounds of stream tin, carrying 55 per cent of tin, was shipped from Tofty Gulch, on Sullivan Creek, between Fairbanks and the mouth of Tanana River. The tin mine near El Paso, Tex., produced 5 tons of metallic tin. The total value was $56,635.

## OCCURRENCE BY STATES.

*Alaska.*—Tin was first discovered in Alaska on Buhner Creek, near York, on Seward Peninsula, in 1900. It occurred here as stream tin, or rolled pebbles of cassiterite, and was found in sluicing for gold. The next year stream tin was found on Buck Creek, which is separated from Buhner Creek by a low divide.

In 1903 cassiterite (tin oxide) was found in place in granite porphyry dikes cutting limestones on Cassiterite Creek, a tributary of Lost River, about 100 miles northwest of Nome. Stream tin was found later in small quantity in the gold placers on Goldbottom Creek, 20 miles north of Nome; at Ear Mountain, in the northern part of Seward Peninsula; with rutile in the gold placers of Cleary, Fairbanks, and other creeks near Fairbanks; with wolframite in the placers of Deadwood Creek, near Circle; and in the placers of Tofty Gulch, on Sullivan Creek, near Hot Springs, on lower Tanana River.

About the time when tin was discovered on Lost River, float ore was found on Cape Mountain, near Cape Prince of Wales, and later its source was found. Constant prospecting effected the discovery of tin in place at the head of Buck Creek; in small quantity on Ear Mountain; and in 1907 Adolph Knopf,[1] of the United States Geological Survey, discovered on Brooks Mountain, near the head of Lost River, two new tin-boron minerals, which he named paigeite and hulsite. Paigeite occurs also on Ear Mountain.[2]

None of the placers has shown importance except those of Buck Creek and, in much less degree, those of Sullivan Creek. From the tin in place the Bartels Tin Mining Co. produced 10 tons of concentrates in 1906, after expending a disproportionately large amount of money, and on Lost River a fair quantity of tin ore is reported to have been exposed.

Buck Creek, on which are the best tin placers now known in Alaska, is about 4 miles long, and is about 16 miles north of York and a little greater distance northeast of Cape Prince of Wales. The creek flows southeastward throughout most of its course. The country rock is a dark sedimentary rock ordinarily called slate, though scarcely as highly altered as the term would imply, and in places contains beds that are rather coarsely sandy. The slate is cut by a few quartz porphyry and greenstone dikes. Into these rocks Buck Creek has cut a comparatively broad valley, which has a long tundra-covered slope on its southwest side. On its northeast side the ground is steep and the creek flows close against the hills throughout much of its course.

The gravel is probably nowhere more than 9 feet deep and extends under the tundra for some distance from the creek. It is all small as compared with that of many placer fields. Very few pebbles are more than 4 or 5 inches in diameter, and most of them are much smaller. There is here and there a bowlder of greenstone a foot or more in diameter, but these bowlders probably form less than 0.04 per cent of the whole.

In the gravel of the creek bed the content of stream tin carrying about 65 per cent metallic tin, has been found to be as high as 400 pounds per cubic yard in rich spots, though the average is much lower. The writer saw one trench dug which gave 28 pounds per cubic yard, and F. P. Kendall, who was at one time in charge of operations on the creek, stated that a season's work gave about the same yield. One large pit gave 25 pounds per yard. In figures furnished the United State Geological Survey the gold in the gravels has been estimated at 40 cents per cubic yard, at $60 per ton of stream tin, and at other amounts. Nuggets of gold up to $20 in value have been found.

When compared with the Australian and Malayan gravels, where the "black tin" content is in many places from 1½ to 5 pounds per cubic yard, with perhaps a heavy overburden not only of soil but, as in Tasmania, of basalt, the gravels of Buck Creek appear very rich, but the climate makes the conditions hard for placer working. The season is short; little or nothing can be done before June 15, and the freeze-up is apt to come by September 15, although the season

[1] Knopf, Adolph, Geology of the Seward Peninsula tin deposits, Alaska: Bull. U. S. Geol. Survey No. 358, 1908, p. 23.
[2] Idem, p. 32.

may open early enough and close late enough to allow between four and five months' work. There are many storms, with cold, heavy rains, but otherwise the country is very healthful.

The gravels were worked first by hand or horse scrapers, then by steam drag shovels, and again by hand until 1911, when a small dredge was put in by the York Dredging Co. The conditions are wholly against hydraulicking, and dredging seems to be the best means of working the gravels.

The dredge, which was specially built for shallow digging, has buckets holding 2½ cubic feet, has gasoline engines for power, and digs from 950 to 1,000 cubic yards each 24 hours. It is equipped with two sluice boxes, so that one can be operated while the other is being cleaned up. The dredge was started on September 10 and as the season was unusually open it ran until October 15. The ground dug is said to have been partly worked before, and the present yield was between 6 and 7 pounds of stream tin per cubic yard. The total output was 92 tons of stream tin averaging 66 per cent tin, or an equivalent of 101 tons carrying 60 per cent tin, and sold for $52,000.

This brings the total production of stream tin from Buck Creek up to about 320 or 325 short tons, estimated as carrying 60 per cent of tin.

During the short run of the dredge a strip 115 by 950 feet was cut out, and it is estimated[1] that there is 3½ miles of such channel. It is also estimated that about three times as much work can be done (100-day run) in future seasons. Should these figures prove true, and, tested by the observations of the Survey's representatives, they seem reasonable, the dredge would have profitable work for several years. There is also tin-bearing ground below the point where the dredge started, and probably some under the tundra that can not be worked with a dredge.

Placer tin has been reported from a number of the small creeks running into the Arctic Ocean from the hills on the northeast side of Buck Creek and from the creeks draining the west side of Potato Mountain, at the head of Buck Creek, but so far no great quantity has been shown to exist.

From present showings no production is to be expected from the veins around Buck Creek.

On Cape Mountain, behind Tin City, where a granite boss intrudes limestones, cassiterite is found in quartz veins, in veins in granite, accompanied by tourmaline and arsenopyrite, and in narrow veins composed almost or wholly of cassiterite cutting the limestones. The quantity of tin present has been greatly overestimated by some of the miners, and there is no immediate prospect of great production. In 1906 the Bartels Tin Mining Co. milled 10 tons of concentrates, the only production up to this time.

On Lost River tin occurs in veins accompanying intrusions of granite porphyry and impregnates the porphyry itself. The veins show much variation. Some cut limestones and carry nothing but cassiterite and quartz; others carry cassiterite, fluorite, and quartz; fluorite and molybdenite; cassiterite, muscovite, and fluorite; stannite, wolframite, topaz, and quartz; cassiterite, tourmaline, danburite, and calcite; and there are also other combinations.

[1] Eddy, L. H., Dredging for placer tin in Alaska: Eng. and Min. Jour., vol. 92, Dec. 23, 1911, p. 1227.

Much work has been performed on this property, and it is now said to show several thousand tons of ore that will pay to work. There has been no production except a few hundred pounds of tin from unimportant placers formed by the breaking down of the veins. Options for the sale of the property have been given several times.

On Brooks Mountain, at the head of Lost River, hulsite and paigeite are found in limestone metamorphosed by granite intrusions. They are iron-tin borates containing 15 to 20 per cent of tin. Some prospecting has been done on the deposit, but the two minerals are low in tin and only a small quantity of them has been found, so that the deposit does not seem likely to prove of commercial value. Furthermore, it is probable that the metallurgical treatment of an iron-tin mineral would prove very difficult.

The only other deposit that promises to be productive is the one found in connection with the gold placers on Sullivan Creek, Tofty Gulch, and Cache Creek, in the Hot Springs district of the lower Tanana. The pebbles are very smooth and show the effects of much water wear. The alluvium is widely and deeply spread over the rocks and the source of the stream tin has not yet been found.[1]

The occurrence is of great interest mineralogically. The pebbles show that the cassiterite has been deposited in cracks in a quartz vein. The cassiterite has also replaced fragments of some rock of which nothing is now left but a cloudy material resembling clay suspended in the cassiterite. The cassiterite is fine grained, appearing so even under the microscope. In this respect it is totally different from any other North American tin ore and resembles some of the ore from the Itos mine, near Oruro, Bolivia. Green and brown tourmaline, topaz (?) in exceedingly fine needles piercing both the grains of cassiterite and the later quartz accompanying it, and fluorite are associated with the cassiterite.

Most of the stream tin has been thrown away, but 1,200 pounds carrying 55 per cent tin was shipped at the end of 1911 by Joseph Eglar, and is said to have netted $209.

*California.*—In the Temescal Mountains near Corona, Cal., a peculiar vein made up of quartz, black tourmaline, and garnet-colored cassiterite cuts a granitic rock. The vein is said to be very irregular and may be largely or wholly a replacement of the wall rock. The vein was discovered in 1853 and there was much excitement over the deposits in 1860 and 1861[2] and again in the eighties. In the latter period about 135 short tons of tin was produced. The deposit is small and there is little likelihood of its being operated again.

*North and South Carolina.*—Pegmatites bearing cassiterite as an original constituent are found through a belt about 2 miles wide and 35 miles long which stretches from Gaffney, Cherokee County, S. C., to Lincolnton, Lincoln County, N. C. The pegmatites cut amphibolite and very old, greatly metamorphosed sediments. They range in width from a fraction of an inch to possibly 30 feet, but most of the dikes exploited for tin have been between 2 and 6 feet wide. They are as diverse in length and depth as in width.

Several tons of cassiterite have been profitably extracted from residual placers at Gaffney by S. S. Ross, and some mining has been

[1] Information from H M. Eakin, of the United States Geological Survey.
[2] Whitney, J. D., Geology: Geol. Survey California, pp. 160–161.

done on a dike. Crystals of cassiterite with faces more than 2 inches across have been taken from the dike.

At Kings Mountain many thousand dollars have been spent on development work, including the erection of a mill. The output has been small, but it is claimed that ore exists that can be extracted at a profit.

At the Jones mine, 9 miles north of Kings Mountain, considerable work has been done, and a small mill was operated for a time. The cassiterite occurs in anhedral masses more than an inch across and, like all found in this field, is very black.

At Lincolnton development work has been prosecuted for a number of years; a mill has been erected, and operations are now in progress on the property of the Piedmont Tin Co. A small production has been made.

*Connecticut.*—A few crystals of cassiterite are reported to have been found near Haddam, Conn., in pegmatite.

*Idaho.*—Wood tin occurs in small quantity in the gold-bearing gravel of Panther Creek, in Prairie Basin, Lemhi County, Idaho, 35 miles west of Samon, and on Hughes Creek, a tributary of South Fork of the Bitterroot.[1] It is apparently not in commercially valuable quantity.

*Maine.*—Small quantities of cassiterite have been found at Winslow, Me., in veins, which are apparently pegmatitic, cutting a country rock of mica schist. Accompanying the cassiterite were lepidolite, fluorite, beryl, and arsenopyrite. Cassiterite has been found as a rare constituent of pegmatites in Paris, Hebron, Stoneham, and Auburn.[2]

*Massachusetts.*—A few small cassiterite crystals have been found in Goshen[3] and Chesterfield,[4] Mass., with albite and tourmaline, probably in pegmatite.

*Montana.*—Wood tin has been reported from Prickly Pear and other creeks in Montana, the gravels of which have been washed for gold. Small specimen bars of tin have been made from wood tin obtained from Big Prickly Pear Creek,[5] but the deposit has no commercial importance as a source of tin.

*New Hampshire.*—Narrow veins at Jackson, N. H., carried cassiterite[6] with arsenopyrite, native copper, copper sulphide and carbonate, wolframite, black tourmaline, and quartz.

*South Dakota.*—Tin occurs in the Black Hills near Hill City, S. Dak., in pegmatites and in quartz veins closely related to them. The pegmatites in places are crushed until gneissoid, and some are mineralogically complex. The most complex dikes, as that on which the Etta claim is located, are less stanniferous than the simpler pegmatites. The dikes cut mica, quartz, and staurolite schists. Certain quartz veins carry both cassiterite and wolframite with a little tourmaline.

---

[1] Lindgren, Waldemar, A geological reconnoissance across the Bitterroot Range and Clearwater Mountains in Montana and Idaho: Prof. Paper U. S. Geol. Survey No. 27, 1904, p. 89.

[2] Dana, J. D. and E. S., System of mineralogy, 6th ed., 1909, p. 235.

[3] Hitchcock, E., Tin in Massachusetts: Am. Jour. Sci., 1st ser., vol. 16, 1829, p. 188.

[4] Emerson, B. K., A mineralogical lexicon of Franklin, Hampshire, and Hampden counties, Mass.: Bull. U. S. Geol. Survey No. 126, 1895, p. 47.

[5] Raymond, R. W., Statistics of mines and mining in the States and Territories west of the Rocky Mountains, 1873, pp. 288–289.

[6] Jackson, C. T., Final report on the geology and mineralogy of the State of New Hampshire, with contributions toward the improvement of agriculture and metallurgy, 1844, pp. 139–145.

During the eighties there was much excitement over tin mining, and the public subscribed several million dollars for stock of a badly managed company, which later failed. Some effort to mine tin has been made unsuccessfully since then, and the Pahasa Mining Co., which took over the assets of the Harney Peak Tin Mining, Milling & Manufacturing Co. in 1909, did much prospecting, but has now ceased operations.

In the northwestern part of the Black Hills, at Tinton, cassiterite occurs as an original constituent of pegmatite dikes composed mainly of muscovite, feldspar, and quartz. The dikes also carry columbite and probably wolframite and scheelite. For a number of years attempts have been made to mine the ore profitably, and a mill was built and recently overhauled. An effort was made to save the muscovite as a by-product to be sold for grinding. A few tons of concentrates have been made, but active operations ceased in 1911.

A small quantity of concentrates has been saved on Bear Creek, where cassiterite occurs with gold and scheelite.

*Texas.*—Cassiterite occurs with quartz as veins and impregnations in light-red aplite cutting granite, on the east base of the Franklin Mountains, 12 miles north of El Paso, Tex. In places cassiterite, quartz, and a little wolframite make a solid vein 2 or 3 inches thick, and in other places the ore is formed from quartz and cassiterite, which have replaced aplite and in which the original quartz grains of the aplite are preserved. In still other places the aplite shows thin veinlets following cracks in the feldspar and here and there spreading out to form grains where the feldspar has been replaced. A small mill and an oil-burning reverberatory furnace have been erected and a few tons of very pure tin have been made, but at the end of 1911 work had stopped, at least temporarily.

A little cassiterite has been found at Streeter, in western Mason County, and a few crystals have been reported from Llano County. These two localities are in an old island of Archean rocks sticking up through much later sedimentaries.

*Virginia.*—Cassiterite from the upper part of Irish Creek in Rockbridge County, Va., 7 miles east of Vesuvius, a station on the Norfolk & Western Railway, was determined by Prof. Armstrong, of Washington College, Lexington, Va., in 1846, and was rediscovered in 1882. The tin occurs in narrow quartz veins cutting a coarse-grained granite. The veins are said to carry arsenopyrite, pyrite, wolframite, beryl, fluorite, siderite, gold, and silver. The granite adjoining the veins is largely converted to muscovite and is impregnated with cassiterite.

Considerable work was done on the deposit and a mill was erected, but for many years the property has been the subject of legal troubles and has remained idle, although it is maintained that the veins contain ore rich enough and in sufficient quantity to be worked profitably. A mill run on 290 tons of ore gave 3.3 per cent metallic tin.[1]

Small specimens of cassiterite have been reported from Nelson County across the Blue Ridge from Irish Creek. So far as known, they have all been float and it seems possible that they came originally from Irish Creek.

[1] Ulke, Titus, Mineral Resources U. S., for 1893, U. S. Geol. Survey, p. 181.

*Washington.*—In 1906 cassiterite was found in pegmatite at Silver Hill, 12 miles southeast of Spokane, Wash. Where the cassiterite occurs [1] the rock is composed mainly of quartz, orthoclase, sillimanite, and andalusite. The dike cuts Archean gneiss, quartzite, and schists. The cassiterite is black, and the individual grains are from very fine to more than an inch across. Some show crystal form and all are somewhat crushed. The deposit was prospected for a year or more and then abandoned, as the tin-bearing rock seemed to have pinched.

*Other States.*—Commercially unimportant discoveries of cassiterite have been reported from several other States, and fraudulent "discoveries" have at different times attracted attention to localities in Utah, Michigan, Missouri, and elsewhere.

## TESTS OF CASSITERITE.

The simplest and easiest test for cassiterite is to place the mineral in dilute hydrochloric or sulphuric acid with granulated, shot, or sheet zinc. The zinc and the acid cause a rapid evolution of hydrogen which takes the oxygen from the tin and leaves a coating of the metal upon the fragment tested. Granulated zinc is best to use, as the small zinc particles can be made to touch the specimen at many points and thus bring more of the hydrogen in contact with the tin-oxide molecules. The reaction is $4H+SnO_2=Sn+2H_2O$.

The metallic coating has a dull-gray, somewhat leaden appearance as formed, but it may be made lustrous by rubbing with a soft cloth or the hand. If the hand is used, the characteristic odor given off when tin is rubbed on the flesh may be noted.

This excellent method may be used upon crystals or other choice specimens which it is desired not to injure. The smooth surface of stream-polished wood-tin is roughened by this process, owing to the impurities contained in the mineral, though the surface of ordinary crystalline cassiterite is not noticeably affected. After the test has been made the metallic tin coating can be removed by immersing the piece in dilute hydrochloric, sulphuric, or nitric acid.

The blowpipe test is better known and is more often used, though not so readily made. The mineral supposed to be cassiterite is pulverized and should yield a light-colored powder, unless mixed with iron oxides, in which case the powder will be reddish or brown. Some cassiterites from the Carolinas and South Dakota, however, give a purplish powder. A small portion of the powder is mixed with twice its bulk of pulverized charcoal and three times its bulk of sodium carbonate or bicarbonate (ordinary washing or baking soda). The three substances are thoroughly mixed, and a portion the size of a pea is moistened and placed in a hollow in a piece of charcoal. On application of a reducing blowpipe flame tin is readily reduced in small globules, which are easily distinguished from the flux. After cooling the metallic globules may be separated from the soda and will be malleable. If large enough they will give the disagreeable tin odor when rubbed between the fingers and will give a white precipitate when treated with concentrated nitric acid. They are soluble in hydrochloric acid, and no precipitate forms when the solution is cold. These reactions with acids differentiate the metal from lead.

[1] Collier, A. J., Tin ore at Spokane, Wash.: Bull. U. S. Geol. Survey No. 340, 1908, pp. 295–305.

## SECONDARY TIN.

Concerning the recovery of tin from secondary sources in 1911, J. P. Dunlop, of the United States Geological Survey, says:

As the production of tin from ore mined in the United States in 1911 was confined to a small quantity of metal smelted in Texas and to the shipment of a small yield of tin concentrates from Alaska, the secondary recoveries of tin form the most important domestic source of supply. The secondary tin recovered in 1911 was equal to 27.4 per cent of the tin imported into the United States during the year. The figures for secondary recoveries in 1911 show an increase of 803 tons in quantity and $2,871,240 in value compared with the recoveries of 1910. The alloys, consisting chiefly of babbitt metal, bronze, and solder, contained 6,957 tons.

The 7,749 tons of recovered tin includes the tin content of products made by several plants from tin scrap. These included some tin oxide, putty powders, etc., but were mainly tin chloride. The production of these compounds is calculated as metal and not separately stated, in order to avoid disclosing confidential data. As the products are made from scrap tin and thus conserve the primary metal to an appreciable extent, they are properly regarded as recovered tin. Two tin chlorides are handled commercially—the stannic and the stannous salt. Stannic chloride is usually sold either as a water solution, called bichloride of tin, or as an anhydrous syrupy liquid, termed tetrachloride of tin, and is used principally in the silk industry. Stannous chloride is sold in the form of crystals and is used in dyeing and calico printing.

The largest recoveries of tin were made from the scruff and drosses that are formed in making tin and terne plate. Practically no clean scrap tin plate is wasted. A large quantity of tin was recovered in the form of tin powder by the electrolytic treatment of such material. This was sold to secondary smelters. Lesser sources of recovered tin reported in 1911 were tin foil, block-tin pipe, and old tin cans. The tin recovered from these sources was of relatively small quantity. Old tin cans were used even less than in previous years. The small percentage of tin coating, the varied nature of the used contents, the bulk, the cost of collection and shipment, and the difficulty of disposing of the old black plate appear to be serious obstacles to their use. To recover the vast quantity of tin wasted on used tin-coated containers is a conservation much needed and desired, but it is evident that such material must be capable of very cheap treatment when it is considered that the original clean tin plate usually has not more than 2 per cent tin coating.

As ascertained by Mr. Dunlop, the production of secondary tin in the United States during 1910 and 1911 was as follows:

*Production of secondary tin in the United States in 1910 and 1911, in short tons.*

| Year. | Recovered as tin. | Recovered in alloys. | Total tin. | Value. |
|---|---|---|---|---|
| 1910 | 7,217 | 6,686 | 13,903 | $9,481,800 |
| 1911 | 7,749 | 6,957 | 14,706 | 12,353,040 |

## IMPORTS.

According to figures collected by the Bureau of Statistics, during the year 1911 the United States imported for consumption 53,527 short tons of tin, valued at $43,346,394; 127 short tons of cassiterite, valued at $68,183; tin foil, valued at $1,692; and other manufactures of tin, valued at $167,950; a total value of $43,584,219. In both quantity and total value the imports exceed those of any other year. The quantity imported in 1910 exceeded previous importations, but the quantity of tin brought in for consumption during 1911 was larger

by 999 tons, and the previous record value ($37,447,315 in 1906) was exceeded by more than $6,000,000.

The imports of tin for consumption into the United States since 1901 have been as follows:

*Tin imported and entered for consumption in the United States, 1901–1911, in short tons.*[a]

| Year. | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1901 | 37,280 | $19,024,761 | 1907 | 41,257 | $32,074,263 |
| 1902 | 42,522 | 21,263,337 | 1908 | 41,267 | 23,923,560 |
| 1903 | 41,567 | 22,265,336 | 1909 | 47,662 | 27,558,546 |
| 1904 | 41,472 | 22,356,895 | 1910 | 52,528 | 33,913,255 |
| 1905 | 44,188 | 26,316,023 | 1911 | 53,527 | 43,346,394 |
| 1906 | 50,477 | 37,447,315 | | | |

[a] These items do not include the tin contained in imported ore, tin foil, or other manufactures.

## WORLD'S SUPPLY OF TIN.

The world's supply of tin, as shown by shipments for the last five years, has been approximately as follows:

*Supply of tin from 1907 to 1911, inclusive, as shown by shipments, in short tons.*

| | 1907 | 1908 | 1909 | 1910 | 1911 [a] |
|---|---|---|---|---|---|
| Total shipments: | | | | | |
| Straits Settlements | 58,800 | 67,760 | 65,459 | 61,152 | 61,712 |
| Australia | 7,112 | 6,552 | 5,992 | 5,208 | 4,480 |
| Bolivia | 17,136 | 19,040 | 23,523 | 19,656 | 25,312 |
| South Africa | | 1,904 | 916 | 3,360 | 3,248 |
| China, to Europe and United States | 224 | | | 2,464 | 2,800 |
| Banka sales in Holland | 12,197 | 12,880 | 12,992 | 15,120 | 16,800 |
| Billiton sales in Java | 2,408 | 2,465 | 2,465 | 2,464 | 2,464 |
| Production in Cornwall | 5,488 | 6,048 | 5,802 | 6,496 | 5,936 |
| Total | 103,365 | 116,649 | 117,149 | 115,920 | 122,752 |

[a] Compiled by C. Mayer, sec., Annual Statistical Review, New York Metal Exchange, New York, 1912, p. 11.

To the world's supply should be added the quantity of secondary tin recovered during the year. The European figures are not available, but are probably equal to those of the United States. If the world's recovery be taken in round numbers as 30,000 short tons, the total supply for 1911 was about 153,000 short tons, an increase of 10,000 tons over the supply for 1910.

## PRICES.

Prices for tin were high and fluctuated considerably during 1911. The American Metal Market and Daily Iron and Steel Report in its "Metal statistics, 1912" (p. 163), gives the average New York price for the year as 42.68 cents a pound. The lowest monthly average price (March) was 40.76 cents a pound. The highest monthly average price was that for June, 46.16 cents. Tin at one time reached 48.50 cents. This price has been equaled or exceeded only once, in 1906, when different authorities quoted the price from 48.50 to 50 cents a pound. The lowest price of the year according to the authority quoted above was 37.60 cents a pound.

## UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS ON TIN.

The following articles on tin have been published by the United States Geological Survey. Those that are out of stock for free distribution can be obtained from the superintendent of documents, Washington, D. C., for the price indicated.


BLAKE, W. P., Tin: Mineral Resources U. S. for 1883–84, U. S. Geol. Survey, 1885, pp. 592–640. 60c.

BROOKS, A. H., Stream tin in Alaska: Bull. U. S. Geol. Survey No. 213, 1903, pp. 92–93. 25c.

COLLIER, A. J., Tin deposits of the York region, Alaska: Bull. U. S. Geol. Survey No. 225, 1904, pp. 154–167. 35c.

——— The tin deposits of the York region, Alaska: Bull. U. S. Geol. Survey No. 229, 1904, 61 pp. 15c.

——— Recent development of Alaska tin deposits: Bull. U. S. Geol. Survey No. 259, 1905, pp. 120–127. 15c.

——— Tin ore at Spokane, Wash.: Bull. U. S. Geol. Survey No. 340, 1908, pp. 295–305. 30c.

GRATON, L. C., The Carolina tin belt: Bull. U. S. Geol. Survey No. 260, 1905, pp. 188–195. 40c.

——— Reconnaissance of some gold and tin deposits of the southern Appalachians, with notes on the Dahlonega mines by Waldemar Lindgren: Bull. U. S. Geol. Survey No. 293, 1906, 134 pp.

HESS, F. L., The York tin region: Bull. U. S. Geol. Survey No. 284, 1906, pp. 145–157.

——— Tin, tungsten, and tantalum deposits of South Dakota: Bull. U. S. Geol. Survey No. 380, 1908, pp. 131–163.

HESS, F. L., and GRATON, L. C., The occurrence and distribution of tin: Bull. U. S. Geol. Survey No. 260, pp. 161–187. 40c.

JOHNSON, B. L., Occurrence of wolframite and cassiterite in the gold placers of Deadwood Creek, Birch Creek district [Alaska]: Bull. U. S. Geol. Survey No. 442, 1909, pp. 246–250. 40c.

KNOPF, ADOLPH., The Seward Peninsula tin deposits: Bull. U. S. Geol. Survey No. 345, 1908, pp. 251–267. 45c.

——— Geology of the Seward Peninsula tin deposits, Alaska: Bull. U. S. Geol. Survey No. 358, 1908, 72 pp.

RICHARDSON, G. B., Tin in the Franklin Mountains, Texas: Bull. U. S. Geol. Survey No. 285, 1906, pp. 146–149. (Entirely out of print.)

——— El Paso folio (No. 166), Geol. Atlas U. S., U. S. Geol. Survey, 1909, 11 pp. 25c.

ROLKER, C. M., The production of tin in various parts of the world: Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1895, pp. 458–538. $1.20.

ULKE, T., Occurrence of tin ore in North Carolina and Virginia: Mineral Resources U. S. for 1893, U. S. Geol. Survey, 1894, pp. 178–183. 50c.

VAN DER WYCK, O. H., The occurrence of tin ore in the islands of Banca and Billiton: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1896, pp. 227–242. $1.

WEED, W. H., The El Paso tin deposits: Bull. U. S. Geol. Survey No. 178, 1901, 15 pp. 5c.

——— Tin deposits at El Paso, Texas: Bull. U. S. Geol. Survey No. 213, 1903, pp. 99–102. 25c.

# ANTIMONY.

By Frank L. Hess.

## PRODUCTION.

During 1911, as in several previous years, the price of antimony was so low that there was little encouragement for American miners to produce the ore unless it contained other metals of sufficient value to pay for production.

No antimony ore is known to have been produced during the year, but, as usual, considerable quantities of antimonial lead were obtained at the smelters of precious metals in the course of their operations, and there was a large recovery of antimony from secondary sources, such as scrap, bearing, and type metals, antimonial lead, drosses, and solder.

At one time the United States Metals Refining Co. made very pure antimony at its electrolytic lead refinery at Grasselli, Ind., but the company reports that none was made during 1911.

The production of antimony in the United States since 1903 has been as follows:

*Production of antimony in the United States, 1903–1911, in short tons.*

| Year. | Contained in antimonial lead of domestic origin. | | Contained in antimonial lead of foreign origin, but smelted in the United States. | | Antimony produced from domestic ore. | | Recovered from old alloys, scrap, dross, etc. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| 1903 | 2,558 | $445,092 | ..... | ..... | 570 | $103,341 | ..... | ..... |
| 1904 | 2,571 | 443,598 | ..... | ..... | [a] 486 | 61,926 | ..... | ..... |
| 1905 | 2,747 | 588,354 | ..... | ..... | 493 | 117,433 | ..... | ..... |
| 1906 | 1,362 | [b] 544,800 | ..... | ..... | [c] 404 | 58,149 | ..... | ..... |
| 1907 | 1,561 | [d] 508,886 | ..... | ..... | [c] 351 | 77,300 | ..... | ..... |
| 1908 | 2,246 | [e] 359,360 | ..... | ..... | [f] | [f] | ..... | ..... |
| 1909 | 1,617 | [g] 252,252 | 743 | [g] $115,908 | [f] | [f] | 1,556 | [g] $242,736 |
| 1910 | 1,598 | [h] 263,431 | 631 | [h] 103,906 | ..... | ..... | [j] 2,779 | [h] 457,979 |
| 1911 | 1,543 | [i] 264,780 | 711 | [i] 122,006 | ..... | ..... | [j] 2,369 | [i] 406,520 |

[a] Estimated from the average content of the ore.
[b] Estimated from the prices current for the year.
[c] Figured as 60 per cent of domestic ores only; direct figures from the smelters could not be obtained.
[d] Estimated, using 16.3 cents as the average price per pound.
[e] Estimated, using 8 cents as the average price per pound.
[f] None produced from domestic ore. Figures not collected for foreign ores.
[g] Estimated, using 7.8 cents as the average price per pound.
[h] Estimated, using 8.24 cents as the average price per pound.
[i] Estimated, using 8.58 cents as the average price per pound.
[j] Figures collected by J. P. Dunlop, United States Geological Survey. In 1910 a total of 9 tons and in 1911 a total of 10 tons was recovered as antimony, the remainder as alloy.

The total of 2,254 tons of antimony was contained in 14,078 tons of antimonial lead, of which the antimony formed 16.01 per cent.

The values given in the table are arbitrary and must not be taken as exact. Antimonial lead generally contains impurities such as arsenic, iron, and copper, and it is impracticable to obtain pure antimony and pure lead from the alloy at such a figure that a profit can be gained, though the alloy sells at a lower price than the metals

singly. A rule by which antimonial lead is sometimes sold is to add the price of the contained antimony, supposing it to be equal to Cookson's, to that of the contained lead and then to subtract $5 per ton. For lack of a better basis, for the year 1911 the value of the antimony content has been figured at 8.58 cents per pound, the average price of Cookson's during the year.

## IMPORTS.

There enters into the consumption of the country a large quantity of antimonial lead imported under the name of type metal, for which it is largely used.

The following table showing imports of type metal for consumption is taken from the records of the Bureau of Statistics:

*Type metal imported and entered for consumption, 1902–1911, in short tons.*

| Year. | Type metal. | | Antimony content.[a] | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Percentage. |
| 1902 | 3,235 | $194,394 | ..... | ..... |
| 1903 | 3,302 | 208,728 | ..... | ..... |
| 1904 | 4,072 | 221,127 | 630 | 15.5 |
| 1905 | 6,966 | 456,155 | 1,228 | 17.6 |
| 1906 | 9,801 | 900,608 | 1,853 | 18.9 |
| 1907 | 7,416 | 932,027 | 1,369 | 18.4 |
| 1908 | 2,055 | 156,847 | 422 | 20.5 |
| 1909 | 6,997 | 532,108 | 1,327 | 19.0 |
| 1910 | 6,697 | 485,493 | 1,109 | 15.1 |
| 1911 | 4,195 | 310,655 | 726 | [b] 17.3 |

[a] Prior to 1904 the composition of the type metal was not given.
[b] The lead content as given amounts to 82.3 per cent, and it is assumed that the remainder is practically all antimony.

Old type weighing 142 tons, valued at $15,835, and new type to the weight of nearly 7 tons, valued at $2,544, were also imported in 1911.

In the following table the imports of antimony and antimony ore for consumption, as obtained from the Bureau of Statistics, are given since 1902 in order to show the great variation in both quantity and value of the imports from year to year. Importations of salts of antimony are given since 1903, the earliest year for which the Survey has obtained statistics.

*Antimony, antimony ore, and salts of antimony imported and entered for consumption in the United States, 1902–1911, in pounds.*

| Year. | Metal and regulus. | | Crude antimony and ore. | | Oxide and salts of antimony. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| 1902 | 5,388,739 | $333,601 | 3,129,069 | $62,968 | ..... | ..... | $396,569 |
| 1903 | 4,694,309 | 260,144 | 2,714,617 | 54,316 | 916,468 | $66,469 | 380,929 |
| 1904 | 4,268,045 | 248,726 | 2,488,518 | 50,414 | 981,026 | 70,668 | 369,808 |
| 1905 | 4,941,247 | 431,228 | 1,970,788 | 53,026 | 1,010,228 | 80,130 | 564,384 |
| 1906 | 10,305,734 | 1,391,289 | 1,972,658 | 125,841 | 764,070 | 99,251 | 1,616,279 |
| 1907 | 9,600,901 | 1,407,861 | 2,771,387 | 180,903 | 682,192 | 98,038 | 1,686,802 |
| 1908 | 8,089,915 | 771,206 | 3,287,218 | 106,930 | 623,125 | 65,898 | 944,034 |
| 1909 | 9,557,956 | 620,117 | 3,453,542 | 94,249 | 955,360 | 60,353 | 774,719 |
| 1910 | 7,955,945 | 492,570 | 1,346,962 | 47,185 | 326,136 | 14,201 | 553,956 |
| 1911 | 8,486,137 | 470,552 | 1,641,467 | 60,459 | [1] 1,003,647 | 54,426 | 585,437 |

[1] Oxide only.

## PRICES.

There has not been a great deal of fluctuation in the price of antimony during the last four years, the extremes as given by the American Metal Market and Daily Iron and Steel Report [1] being 7.5 and 9.5 cents a pound for Cookson's antimony. These were also the extreme prices for 1911. Hallett's generally sells for about a cent a pound less than Cookson's, and other brands are lower according to quality and to reputation, which seems to be fully as important.

Trade papers in the earlier part of 1911 reported the formation of a syndicate for the raising of prices, which advanced from about 8.5 to 9.5 cents a pound for Cookson's antimony, but by July the price was back at 8.5 cents, and it gradually fell until the close of the year, when 7.81 cents a pound was quoted.[2]

## SECONDARY ANTIMONY.

The production of secondary antimony—that is, of antimony recovered from waste materials—in the United States in 1911 was 10 short tons, and 2,359 tons was recovered in alloys. The output was valued at $359,040. In 1910 the recovery was 9 and 2,770 tons, respectively, valued at $444,600.

## CONSUMPTION.

Roughly, the consumption of antimony in the United States is indicated by the antimony produced from domestic and foreign ore, the secondary or recovered antimony, the antimony in antimonial lead, the imported antimony, the antimony contained in imported type metal, and the antimony contained in imported oxide and salts. The consumption in 1910 and 1911 may be shown thus:

*Consumption of antimony in the United States, 1910–1911, in short tons.*

| | 1910 | 1911 |
|---|---|---|
| Antimony from domestic and foreign ores (estimated as 60 per cent of ore) | 419 | 492 |
| Secondary or recovered antimony | 2,779 | 2,369 |
| Contained in antimonial lead of domestic origin | 1,598 | 1,543 |
| Contained in antimonial lead of foreign origin | 631 | 711 |
| Imported antimony | 3,978 | 4,243 |
| Contained in imported type metal | 1,109 | 726 |
| Contained in antimony oxide | | 418 |
| Total | 10,514 | 10,502 |

Besides these quantities there were smaller quantities of antimony oxide and salts in 1910 and some old and new types consumed in both years.

[1] Metal Statistics, 1912, p. 209.

[2] Op. cit., p. 210.

# BISMUTH.

By Frank L. Hess.

So far as was made known to the United States Geological Survey, the only bismuth-bearing ore produced in the United States during 1911 was one lot from the Comstock mine, La Plata, La Plata County, Colo., which carried 6 to 8 per cent of bismuth but was sold for its gold and silver content, and a smaller lot of richer ore mined by George E. Stone from a claim about 35 miles southwest of Tularosa, N. Mex.

The United States Metals Refining Co. made metallic bismuth from the residues left in refining lead at its Betts process electrolytic refinery, at Grasselli, Ind., and smaller quantities were probably saved at one or more other refineries. The bismuth is probably largely from Tintic (Utah) lead ores, smelted at Bingham Junction, Utah, but other ores from other parts of the United States are also smelted.

According to figures published by the Bureau of Statistics, 172,093 pounds of bismuth, valued at $311,771, were imported for consumption in 1911.

*Imports for consumption of metallic bismuth into the United States, 1904–1911, inclusive, in pounds.*

| Year. | Quantity. | Value. |
|---|---|---|
| 1904 | 185,905 | $339,058 |
| 1905 | 148,589 | 318,007 |
| 1906 | 254,733 | 318,452 |
| 1907 | 259,881 | 325,015 |
| 1908 | 164,793 | 257,397 |
| 1909 | 183,413 | 286,516 |
| 1910 | 198,174 | 332,668 |
| 1911 | 172,093 | 311,771 |

As in former years, the price of bismuth appeared to be governed closely by foreign firms and was quoted by the technical press at $2.10 to $2.15 a pound through the year. The prices per pound of bismuth salts were quoted as follows: Citrate, $2; salicylate, $1.60; subcarbonate, $2.10; subgallate, $1.65; and subnitrate, $1.80.

# SELENIUM.

By Frank L. Hess.

A considerable quantity of selenium is now obtained as a by-product in electrolytic copper refining in several refineries, but as the production during 1911 was the output of only two companies the figures may not be given. The industry has passed the experimental stage, and may be considered to be on a permanent basis.

None is known to have been imported.

The principal uses are in the manufacture of red glass, enamels, and glazes.

In 1910 the output was reported as 10,674 pounds, valued at about $35,000, the price ranging from $3 to $5 a pound. The output was larger in 1911 and the average price was lower, being nearer $3 a pound.

# CHROMIC IRON ORE.

By W. C. Phalen.

## PRODUCTION.

The production of chromic iron ore or chromite in the United States in 1911 amounted to 120 long tons, valued at $1,629. This production represents the quantity actually sold. The quantity actually mined was considerably greater, but some of the ore mined was not sold, owing in part to a somewhat curtailed demand and in part to the difficulties of transportation. The ore sold came from Shasta, Siskiyou, and Tehama counties, Cal. Some ore was reported as having been mined in Converse County, Wyo.

The following table gives the quantity and value of chromic iron ore produced in the United States since 1880. All the ore came from California, except in 1908 and 1909, when part came from Wyoming:

*Production of chromite in the United States, 1880–1911, in long tons.*

| Year. | Quantity. | Value. | Year. | Quantity. | Value. |
|---|---|---|---|---|---|
| 1880 | 2,288 | $27,808 | 1896 | 786 | $6,667 |
| 1881 | 2,000 | 30,000 | 1897 | ..... | ..... |
| 1882 | 2,500 | 50,000 | 1898 | ..... | ..... |
| 1883 | 3,000 | 60,000 | 1899 | ..... | ..... |
| 1884 | 2,000 | 35,000 | 1900 | 140 | 1,400 |
| 1885 | 2,700 | 40,000 | 1901 | 368 | 5,790 |
| 1886 | 2,000 | 30,000 | 1902 | 315 | 4,567 |
| 1887 | 3,000 | 40,000 | 1903 | 150 | 2,250 |
| 1888 | 1,500 | 20,000 | 1904 | 123 | 1,845 |
| 1889 | 2,000 | 30,000 | 1905 | 22 | 375 |
| 1890 | 3,599 | 53,985 | 1906 | 107 | 1,800 |
| 1891 | 1,372 | 20,580 | 1907 | 290 | 5,640 |
| 1892 | 1,500 | 25,000 | 1908 | 359 | 7,230 |
| 1893 | 1,450 | 21,750 | 1909 | 598 | 8,300 |
| 1894 | 3,680 | 53,231 | 1910 | 205 | 2,729 |
| 1895 | 1,740 | 16,795 | 1911 | 120 | 1,629 |

## PRICES.

From the tables of domestic production and importation of chromic iron ore it will be seen that the former is relatively insignificant. The price of domestic ore—that is, California ore—was $13.57½ per long ton in 1911, and the price is usually contingent on grade of ore and balance between local supply and demand. California ore is used principally in the manufacture of furnace linings.

Imported ore from New Caledonia carrying 50 per cent chromic oxide was quoted in New York during 1911 at from $14 to $16 per long ton, the price being for carload lots and exclusive of cost of

transportation. The price of chrome bricks f. o. b. Pittsburgh was $175 per thousand throughout the year.

The price of potassium bichromate varied slightly during 1911. In the early part of the year it was 7⅞ to 8 cents per pound, and this price held from the beginning of the year up to and through May. In June the quotations were 7⅞ to 7¾ cents per pound, which held until December, when the price fell to 7⅛ to 7⅜ cents per pound. The Scotch product was quoted at 10¾ cents per pound from the beginning of the year up to and including August.

The price of sodium bichromate ($Na_2Cr_2O_7$) from the beginning of the year up to and including May was 5⅝ to 6¼ cents per pound. In June the price decreased slightly to 5⅜ to 5¾ cents, and in December still another fall took place to 5 to 5¼ cents per pound.

## IMPORTS.

During the last seven years important quantities of chromite have been imported from New Caledonia, Greece, Canada, Great Britain, Asiatic Turkey, and Japan, and minor quantities from European Turkey, Belgium, Germany, France, Cuba, Australia, Tasmania, New Zealand, and Portuguese Africa. Revised figures of the shipment of chromite from Canada in 1910 were reported as 299 short tons, valued at $3,734, which was the production of the country for that year. The production of Canada for 1911 (subject to revision) was 27 short tons, valued at $351. These figures are probably too low.

The importations of chromic iron ore in 1911 were 37,540 tons, valued at $407,958, a decrease of 1,039 tons in quantity and of $7,810 in value as compared with 1910. In the following table is given the imports for consumption of chromic iron ore and the manufactured chromium salts, etc., imported into the United States during the last five years. The importation of chromate and bichromate of sodium during 1911 was reported at 11 pounds, valued at $1.

*Chromate and bichromate of potash, chromic acid, and chrome ore imported and entered for consumption in the United States, 1907 to 1911, inclusive.*

| Year. | Chromate and bichromate of potash. | | Chromic acid. | | Chrome ore. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | *Long tons.* | | |
| 1907 | 18,171 | $1,307 | 1,834 | $403 | 41,989 | $491,925 | $493,635 |
| 1908 | 216,081 | 15,453 | 3,805 | 708 | 27,876 | 345,960 | 362,121 |
| 1909 | 537,017 | 28,837 | 7,559 | 1,412 | 39,624 | 460,758 | 491,007 |
| 1910 | 406,790 | 19,569 | 9,850 | 1,635 | 38,579 | 415,768 | 436,972 |
| 1911 | 22,408 | 2,159 | 6,789 | 1,349 | 37,540 | 407,958 | 411,466 |

## NOTES ON CHROMIC IRON ORE.

### SOURCES OF ORE.

Chromite or chromium iron ore is the only important commercial source of the element chromium. This element is known, however, to occur as a constituent in many other less well-known minerals, as appears from the following list:

*Partial list of chromium minerals.*

| | |
|---|---|
| Picotite (chrome spinel) | $(MgFe)O\ (AlCr)_2O_3$ |
| Crocoite | $PbO\ CrO_3$ |
| Phoenicochroite | $3PbO\ 2CrO_3$ |
| Vauquelinite | $2(PbCu)O\ CrO_3\ 3(PbCu)O\ P_2O_5$ |
| Uvarovite (chrome garnet) | $3\ CaO(AlCr)_2O_3\ 3SiO_2$ |
| Chrome diopside | $CaMg(SiO_3)_2\ nCr_2O_3$ |
| Emerald (chrome beryl) | $3BeO\ Al_2O_3\ 6SiO_2\ nCr_2O_3$ |
| Redingtonite | Hydrous chromium sulphate |

Fuchsite (chromium mica), mariposite.

Chromite, the commercial source of chromium, is theoretically a mixture of chromic oxide ($Cr_2O_3$) and ferrous oxide (FeO) with the symbol $FeO.Cr_2O_3$. Theoretically it contains 68 per cent of the former and 32 per cent of the latter oxide; as a matter of fact, however, the two oxides are present in widely varying proportions. The percentage of chromic oxide generally ranges from 40 to 60 per cent, but it may be as low as 10 per cent; the percentage of ferrous oxide may range from 10 to 50 per cent. The ore is usually purchased on a basis of 50 per cent chromic oxide. Alumina and magnesia are usually present in the ore, sometimes in considerable quantities. Alumina replaces the chromic oxide, and magnesia replaces the ferrous oxide.

## DISTRIBUTION OF ORE.

### DOMESTIC ORE.

Chromic iron ore is widely distributed through areas of serpentine and associated basic rocks in different parts of the United States. Serpentine areas have been found in a few localities in the old metamorphic rocks east of the Appalachian region from New England to Georgia, at various points in the Rocky Mountain region, throughout the extent of the Sierra Nevada and Coast Ranges in California, and at a few points in the Cascade Mountains. It occurs widely disseminated through many of these areas, but only locally is it concentrated into workable quantity. In the United States deposits of chromic iron ore are known in Massachusetts, Pennsylvania, Maryland, North Carolina, Wyoming, and California, and in the black sands of the Pacific coast.

### FOREIGN ORE.

Within the last few years chromite has been produced mainly in New Caledonia, Rhodesia, Asia Minor, Russia, Greece, Canada, India, and Japan.

#### RHODESIA.

Rhodesia and New Caledonia are the two countries producing most of the chromic iron ore at the present time and are also the countries in which development seems most promising. The Rhodesian deposits may be cheaply mined and shipped to seaport at a low rate, so that their production has increased rapidly, notwithstanding their remoteness from market and the facts that the production of chromic iron ore has been irregular during recent years and that the demand does not appear to be increasing.

Consul G. A. Chamberlain[1] has furnished the following table concerning shipments of Rhodesian chromic iron ore through the port of Beira to the several countries of the world in 1908 and 1909:

*Rhodesian chrome ore shipments in 1908 and 1909, by countries, in long tons.*

| Country. | 1908 | 1909 |
|---|---|---|
| United States | 4,225 | 11,470 |
| Netherlands | 3,612 | 5,102 |
| France | 3,290 | 3,717 |
| Italy | ..... | 1,000 |
| Belgium | 490 | 905 |
| United Kingdom | 306 | 677 |
| Total | 11,923 | 22,871 |

This table is of interest for two reasons: (1) It shows that the shipments nearly doubled in 1909 as compared with 1908, and (2) that one-half the quantity shipped in 1909 went to the United States—practically all through the port of Baltimore. During 1910 [2] shipments amounted to 44,002 long tons valued at $477,559 (£98,132). The total Rhodesian production to date is 94,044 long tons, valued at $1,101,873 (£226,420). The output increased rapidly during 1911 and in the month of April alone its value was $85,772 (£17,625).

The following brief notes on the Rhodesian deposits are taken from the Engineering and Mining Journal:[2] The important deposit of chromic iron ore occurring at Selukwe, Rhodesia, is a huge segregated mass associated with serpentine. It is easily mined, the supply is large, the cost of mining is low, and the deposit is in close proximity to the railway. Hence the production has increased rapidly, notwithstanding the remoteness of the deposits from market.

Chromite is known in other parts of southern Rhodesia—for example, at Victoria, Makwiro, and Lomagundi—and it is not unlikely that these deposits contain large bodies of ores. The chromic-oxide content of these ores varies, and is sometimes low as at Makwiro. The deposits appear to be connected with the great intrusion of picrite which runs north and south through southern Rhodesia from Zambesi River almost to the Limpopo, and is marginally altered to serpentine in several places.

### NEW CALEDONIA.[3]

A large proportion of the world's present production of chromic iron ore comes from New Caledonia, a French possession, east of Australia. The mineral was discovered here in 1874. In the deposits in the southern part of the island, the ore occurs (1) as rich, soft, and easily broken masses in a ferruginous clay, and (2) in the forms of veins and masses in serpentine. The more friable ore, being the more easily separated from the country rock, is mainly sought after.

The only chromic iron ore mine on the island which is worked below the surface is the Lucky Hit in the group of mines to the south of Noumea. This ore as mined contains from 30 to 40 per cent chromium sesquioxide and is concentrated mechanically to raise it to marketable quality.

[1] Daily Cons. and Trade Repts., July 12, 1910. [2] Eng. and Min. Jour., Nov. 11, 1911, p. 955.
[3] Min. World, Apr. 29. 1911, p. 885.

The largest deposits are in the northern part of the island around the Tiebaghi mine, the yield from which is approximately 4,000 tons of ore per month, containing up to 67 per cent chromium sesquioxide.

### MACEDONIA.[1]

In the revival of the mining industry which occurred in Macedonia 40 years ago attention was first directed to the deposits of chromic iron ore. Since 1907, however, there has been a halt in the mining operations of Macedonia caused by the discovery of great deposits of chromic iron ore in New Caledonia and South Africa. Strong competition sprang up between the two latter countries, and in a short time the price of chromic iron ore dropped from $25 to $12.50 per ton c. i. f. On account of transportation difficulties, bad roads, and distance from the seacoast, the mines of Macedonia could not compete at these prices and they were all forced to close down.

The following notes have been compiled from descriptions by Vice Consul John L. Binda, Saloniki, Turkey:

The important producers in Macedonia during the active period of mining chromic iron ore in Turkey were the Ostrovitza, Roshdam, Radousha, Allshar, Loyan, Sfiltche, Varissa, Goranza, and Tourhanli mines. At most of these mines the ore is of good quality, and in some of them it is excellent; the percentage of chromic oxide present ranges from 45 per cent in one low-grade vein at the Sfiltche mine to a maximum of 54 per cent in some of the ore from the Roshdam mine. The ore after being mined is transported to the nearest railroad station either by packing or on small wagons, or by both methods, and thence by rail to Saloniki, whence it is shipped. From one mine, the Tourhanli, the ore is transported directly to Saloniki by wagons. The cost of the ore f. o. b. Saloniki depends on several items and varies from $5.72 per ton for ore from the Tourhanli mine, which is transported 10 miles in wagons to Saloniki and thus avoids the cost of railroad transportation, to $12.94 per ton for ore from the Ostrovitza mine. The cost of the ore includes the following items: (1) Extraction; (2) transportation overland to nearest railroad shipping point; (3) transportation by rail to Saloniki; (4) royalties to holders of ancient concessions or to previous owners; (5) customs duty [2] and Government revenues; (6) charges for loading aboard steamer.

For the mines for which data are available the cost of (1) varies from $1.32 to $2.86 per ton; of (2) from $1.54 to $6.16 per ton; of (3) from nothing in the case of ore from the Tourhanli mine, which is hauled by wagons to Saloniki, to $2.68 per ton; (4) from 88 cents to $1.58 per ton; of (5) from $1.76 to $1.93 per ton; of (6) from 66 cents to 75 cents per ton.

## NOTES ON CHROMIC IRON ORE INDUSTRY.[3]

In contradistinction to most mineral production, chrome mining in the last 10 or 15 years has been a fluctuating and declining industry. Prices have been generally on the downward trend, which is a curious circumstance when the quotations for vanadium and tungsten ores

[1] Daily Cons. and Trade Repts., Dec. 23, 1911, pp. 1508–1509.

[2] The export duty is 1 per cent ad valorem; the remainder of this item represents charges imposed under the Turkish mining law. A copy of the mining law (in French), on file in the Bureau of Manufactures, will be loaned to those interested.

[3] Min. Jour., London, May 20, 1911, pp. 521–522.

as ingredients in special steel alloys, one of the uses of chromium, are considered. The chief reasons are probably to be found in the wide distribution of chromic iron ores and the pockety character of known deposits of ores free from impurities. Within the last few years the ore has been produced mainly in New Caledonia, Asia Minor, Russia, Greece, Canada, India, Rhodesia, and Japan. The supply from New Caledonia, which is probably the best-known source of production, has fluctuated greatly, having been as high as 84,241 metric tons in 1906, and falling to 3,800 metric tons in the following year. Turkish statistics are wanting. In Russia, where the industry centers in the Urals, the erection of a factory to treat the ores does not appear to have led to increased working; the latest statistics are those for 1908, when the output was given as 9,278 tons, against 25,850 tons in 1907. Great activity was seen in India some three or four years ago in working the deposits in Baluchistan and Mysore, the output rising to 18,957 tons in 1907; but the production declined with almost equal rapidity. Apart from the New Caledonia production, which is mainly from the Tiebaghi mines, the chief producer at the present time is Rhodesia, where the output has increased very rapidly from a few thousand tons in 1906 to 44,000 tons in 1910, and the figures for 1911 indicate a still further growth. The mines are in the neighborhood of Selukwe, and the mineral has to stand a railway haul of some 560 miles to the port of Beira, the transportation costing, according to the Écho des mines, about 11s. ($2.68) per ton, or about half a cent per ton per mile, a rate which bears testimony to the difficulty of obtaining return freight to the coast, and is no doubt one of the chief reasons why the deposits can be successfully exploited. When to this is added the ocean freight and the fact that recent prices have been between 45s ($10.95) and 47s. 6d. ($11.56) per ton for ore containing 50 per cent of chromium sesquioxide—the Rhodesian ore, in fact, averaged £2 7s. 1¾d. ($11.48) in 1909, and £2 4s. 7½d. ($10.85) in 1910—it will be realized that deposits must be favorably situated for easy working before they can be considered commercially attractive. The Rhodesian development is an interesting one, therefore, as indicating how ores from deposits in a comparatively inaccessible part of the world may be placed upon the European market under conditions which enable them to compete with more favorably situated supplies owing to the artificial conditions created by great railway development schemes—a circumstance which is perhaps somewhat overlooked in considering the competition to be expected from mineral regions situated far from the sea when transport facilities are still incomplete.

Even if the Tiebaghi mines should be closed down so as to reduce the world's supplies, there can not be seen much opportunity of raising prices very considerably, certainly to the former level of say £6 ($29.20) a ton. A review even of recent years shows a wide distribution of mining and considerable outputs from countries which have gone temporarily out of production, but which a rise in price would quickly bring back into the market again. Statistics are not easy to get in complete form, but the following, which are the best obtainable, sufficiently illustrate the point.

*World production of chromic iron ore, 1906–1910, in metric tons.*

| Country. | 1906 | 1907 | 1908 | 1909 | 1910 |
|---|---|---|---|---|---|
| Bosnia | 320 | 310 | 500 | ..... | ..... |
| Greece | 11,530 | 11,730 | 4,350 | ..... | ..... |
| Russia | 16,976 | 26,357 | 9,278 | ..... | ..... |
| Asia Minor (Turkey) | ..... | 28,860 | ..... | ..... | ..... |
| India | 4,445 | 18,597 | 4,821 | 9,350 | ..... |
| Japan | ..... | 2,290 | 2,204 | ..... | ..... |
| United States | 109 | 295 | 365 | 208 | ..... |
| Canada | 8,196 | 6,528 | 6,555 | 1,627 | ..... |
| South Rhodesia | 3,308 | 7,273 | 12,118 | 26,140 | 44,002 |
| New South Wales | 15 | 30 | ..... | ..... | ..... |
| New Caledonia | 84,241 | 3,800 | 15,800 | 32,006 | ..... |

Where blanks occur in this table it does not necessarily mean that production has ceased, only that statistics are not available. It will thus be seen that there was a probable production from 1906 to 1910 of hardly less than 80,000 tons a year, yielding, say, half that quantity of metal. * * * In spite of falling prices, chromium seems to have been losing ground in the arts in recent years.

## USES OF CHROMIUM.

The main uses of chromium are in pigments and in special tanning processes. It is also used as an ingredient for furnace linings and to a limited extent in steel alloys, but on a whole less is heard of chrome steels than formerly. Very full descriptions of the applications of chromium appeared in this chapter for 1908, and they will not now be detailed.

Chromium has been a metal of commercial importance for only about 15 years. It is made in the metallic state by reduction of the oxide by metallic aluminum and also by electrolysis of its salt solutions. It can not yet be produced at a lower cost than that of the aluminum required, and it now sells at about 80 cents per pound. In its alloys with iron, which are made by direct reduction with carbon, it is sold for 29 cents a pound. This gives a rough idea that ultimately, by perfection of metallurgical processes, etc., the metal may be obtained at a price much below 80 cents a pound. It withstands heat exceedingly well. When pure it melts at a high temperature (according to Ostwald, at about 3,000° C.), and it does not scale when heated red hot in air, as copper and iron do. It is for this reason that it is used in resistance alloys for electric heating devices. It has been plated on metals, and it then looks and acts like nickel plate. Doubtless its use will increase in special alloys, as it has already come into use in tool steel.[1]

## ALLOYS CONTAINING CHROMIUM.

According to C. Vickers [2]—

A new high-tensile copper alloy, recently developed in France, is made by melting chromium and aluminum together at a high temperature for one hour, the proportions of each metal being 11 pounds. When the aluminum and chromium have been thoroughly incorporated, 242 pounds of copper are added, and the entire charge is held in a molten condition in the furnace for a period of one-half hour, after which 55 pounds of nickel are added and another hour period of soaking follows. The metal is

[1] Eng. and Min. Jour., June 3, 1911, p. 1094. [2] The Foundry, March, 1912, pp. 107–108.

held in the furnace a total of two and one-half hours, which is contrary to the practice of melting alloys of copper. After the nickel has been added and at the end of the period of rest, 44 pounds of zinc are alloyed with the mixture, which is then poured into ingots. The proportions of copper and chromium can be varied in accordance with the use for which the alloy is intended, but no change is permissible in the quantity of aluminum, or the order in which the metals are to be added. * * *

*Chromax bronze.*—In this country chrome-nickel bronze is being manufactured by the Naulty Smelting & Refining Co., Philadelphia, the product being known as chromax bronze. The composition of this alloy is similar to the French metal, and to all intents and purposes it is the same. The proportions of the metals in the mixture are said to be as follows: Copper, 66.66 per cent; zinc, 12.13 per cent; nickel, 15.15 per cent; chromium, 3.03 per cent; and aluminum, 3.03 per cent. The tensile strength of the alloy is 79,000 pounds per square inch, and there is reason to believe that this figure is not too high. The elongation is 3.3 per cent.

# PLATINUM AND ALLIED METALS.

By Waldemar Lindgren.

## PLATINUM.

### DOMESTIC PRODUCTION.

#### CRUDE PLATINUM.

The production of crude platinum in the United States increased somewhat in 1911, this increase being undoubtedly due to the high prices paid for the metal. The production reported in 1911 was 628 troy ounces, an increase of 238 ounces compared with the output of 1910. The reported value in 1911 was $18,137, or $8,630 more than in 1910. The average price paid per ounce of crude platinum sand was $28.87, compared with $24.38 in 1910. The crude platinum sand generally contains a little iridium, iridosmine, and gold, besides some remaining black sand. The platinum content of the crude sands varies considerably, the average in this country being about 70 per cent.

The entire output of crude platinum in the United States is recovered from placer mines in Oregon and California, which also produce gold. The production of California in 1911 amounted to 511 troy ounces, valued at $14,873; the output in 1910 was only 337 ounces, valued at $8,386. Of the California product 488 ounces were recovered as a by-product in dredging operations in Butte, Yuba, Sacramento, and Calaveras counties, 205 ounces being derived from Butte County and saved in the dredging of gold-bearing gravels at Oroville. Smaller quantities were recovered from placer operations of various kinds in Calaveras, Del Norte, Humboldt, Placer, Siskiyou, and Trinity counties.

In Oregon the quantity recovered in 1911 was 117 ounces, having a reported value of $3,265. The production in 1910 was 53 troy ounces, valued at $1,121. The ocean beaches in Coos and Curry counties yielded 50 ounces. The remainder came mainly from placer mines in Josephine County, near Kerby.

#### REFINED PLATINUM.

##### PRODUCTION FROM PLATINUM SANDS.

The production of refined platinum from crude metal derived from placers is calculated on the basis of a content of fine metal of 70 per cent, and, thus computed, 440 fine ounces is found to have been the output from domestic placers in 1911.

In 1911 crude platinum sand was imported into the United States to the amount of 34,412 ounces. Assuming a content of fine platinum of 80 per cent we arrive at the approximate figure of 27,500 ounces of refined platinum produced in the United States in domestic refineries from foreign sands.

### PRODUCTION FROM GOLD AND COPPER BULLION.

In calculating the production from bullion there is some difficulty because of some refineries like that of the United States Mint, the output of which is in large part derived from secondary sources—that is, from scrap platinum and from sweepings, etc., bought from jewelers and dentists. During 1910 private refineries also began the separation of platinum metals from gold bullion.

According to the best estimate that can be made domestic refineries produced in 1911 about 1,200 fine ounces of platinum from bullion. It is not possible to differentiate between that derived from domestic and that from foreign ores. Probably not more than 500 ounces were obtained from bullion derived from domestic mines.

In conclusion, the total quantity of refined platinum produced in domestic refineries would be approximately 29,140 fine ounces, of which only about 940 ounces, valued at $40,890, were derived from domestic sources of various kinds. The corresponding estimate in 1910 was 773 ounces, valued at $25,277.

### PRODUCTION OF PLATINUM FROM LODE MINES.

Most of the platinum recovered is contained in the gold and copper bullion only in very small quantities, and consequently it is in still smaller quantities in the original ores, which can therefore not be considered as platinum ores. During 1911 a shipment of material which may properly be classed as a copper-platinum-palladium ore was made from the New Rambler mine, in Wyoming. The quantity recovered was not large compared to the total production of refined platinum given above, but nevertheless the shipment constitutes a notable event.

The New Rambler mine, as described by S. F. Emmons,[1] is situated in the Medicine Bow Range about 32 miles west of Laramie. The deposit which mainly contains oxidized copper ores and secondary covellite is contained in dioritic rock of pre-Cambrian age. The original form and nature of the deposit could not be determined. H. L. Wells and S. L. Penfield[2] found that sperrylite (arsenide of platinum) was contained in well-defined crystals in this ore in association with covellite and pyrite. The occurrence of platinum in the ore was first announced by Prof. Wilbur C. Knight. It is reported that the rich ores and concentrates shipped contained about 0.5 ounce of platinum and 1 ounce of palladium per ton. A secondary concentration of the platinum metals has doubtless been effected during the oxidation of the deposits.

According to a statement in the Engineering and Mining Journal,[3] some of the concentrates examined by Ledoux & Co. assayed 14.66 ounces per ton in platinum and 2.82 ounces in gold. The sample

[1] Platinum in copper ores in Wyoming: Bull. U. S. Geol. Survey No. 213, 1903, pp. 94–97.
[2] Am. Jour. Sci., 4th ser., vol. 13, 1902, p. 95.
[3] Eng. and Min. Jour., Mar. 4, 1911, p. 460.

contained some silver, considerable palladium, and a small quantity of iridium. A specimen of covellite from the mine yielded 1.8 ounces per ton of platinum and 1.1 ounces of gold. A small quantity of palladium was also noticed in this sample. The gold is principally in the free state, but these metallic particles contain no platinum. Low-grade ore from the mine was found to contain 0.25 ounce of platinum and 0.03 ounce of gold, besides a trace of palladium.

The owners of the New Rambler mine have built an experimental mill with the capacity of 150 tons per day, and are experimenting on the problem of the utilization of the lower-grade ores.

The New Rambler deposit is not unique among the occurrences in the Western States. A deposit discovered some years ago in southern Nevada east of Moapa consists of a dike of peridotite which contains copper minerals and carries a little platinum, as described in Mineral Resources for 1908 and in a recent bulletin of the Survey.[1]

## PRICES.

The strong demand for platinum and the remarkable rise in quotations which began in 1910 continued throughout 1911. The year began with refined platinum quoted at about $39 per ounce. There was an almost uninterrupted increase in price until November and December, during which months the price had risen to $46 per ounce. At the end of December $48.50 was paid. The demand abated somewhat in the first months of 1912.

The following table gives the prices of ingot platinum per troy ounce at New York, by months, for the calendar years 1908, 1909, 1910, and 1911:

*Prices of ingot platinum per troy ounce on the New York market in 1908, 1909, 1910, 1911, by months.*

**1908.**

| | | | |
|---|---|---|---|
| January | $22.30 | July | $19.60 |
| February | 22.10 | August | 18.20 |
| March | 21.80 | September | 18.60 |
| April | 21.75 | October | 21.15 |
| May | 21.35 | November | 24.50 |
| June | 19.85 | December | 24.10 |

**1909.**

| | | | |
|---|---|---|---|
| January | $24.25 | July | $22.50 |
| February | 24.50 | August | 22.00 |
| March | 23.75 | September | 25.50 |
| April | 24.00 | October | 28.00 |
| May | 23.50 | November | 29.25 |
| June | 23.00 | December | 29.50 |

**1910.**

| | | | |
|---|---|---|---|
| January | $29.00 | July | $33.00 |
| February | 28.75 | August | 33.00 |
| March | 29.13 | September | 33.63 |
| April | 29.25 | October | 37.50 |
| May | 29.55 | November | 39.44 |
| June | 31.38 | December | 38.75 |

[1] Bancroft, Howland, Platinum in southeastern Nevada: Bull. U. S. Geol. Survey No. 430, 1910, pp. 192–199.

*Prices of ingot platinum per troy ounce on the New York market in 1908, 1909, 1910, 1911, by months*—Continued.

1911.

| | | | |
|---|---|---|---|
| January | $39.03 | July | $42.98 |
| February | 39.35 | August | 44.35 |
| March | 41.02 | September | 45.32 |
| April | 41.33 | October | 46.22 |
| May | 48.85 | November | 46.10 |
| June | 42.86 | December | 46.05 |

The average price in 1910 was $32.70 per ounce and in 1911 it was $43.50. Quotations are from the Engineering and Mining Journal of New York City.

Hard metal, which contains about 10 per cent iridium, is quoted about $2.50 per ounce higher than refined platinum.

## IMPORTS AND EXPORTS.

*Platinum imported and entered for consumption in the United States, 1902–1911.*

| Year. | Platinum ore or crude platinum, including unmanufactured products, ingots, bars, sheets, and wire. | | Manufactured products, including vases, retorts, etc. | Total. |
|---|---|---|---|---|
| | Quantity. | Value. | Value. | Value. |
| | *Troy ounces.* | | | |
| 1902 | 88,140 | $1,950,362 | $37,618 | $1,987,980 |
| 1903 | 92,808 | 1,920,044 | 135,889 | 2,055,933 |
| 1904 | | | | 1,879,155 |
| 1905 | 93,912 | 1,985,107 | 188,156 | 2,173,263 |
| 1906 | 137,928 | 3,601,120 | 187,639 | 3,788,759 |
| 1907 | 74,292 | 2,508,991 | 175,651 | 2,684,642 |
| 1908 | 50,844 | 1,095,754 | 134,119 | 1,229,873 |
| 1909 | 118,853 | 2,557,596 | 416,352 | 2,973,948 |
| 1910 | 118,280 | 3,320,699 | 333,965 | 3,654,664 |
| 1911 | [a] 122,751 | [b] 4,723,489 | 142,718 | 4,866,207 |

[a] Includes 34,412 troy ounces of platinum ore or crude platinum and 88,339 troy ounces of unmanufactured products, ingots, bars, sheets, and wire.

[b] The value of platinum ore or crude platinum was $1,278,239 and of unmanufactured products, ingots, bars, sheets, and wire $3,445,250.

The only exports recorded are under the heading of "Exports of foreign merchandise," and for the calendar year 1911 amounted to 181 ounces, valued at $8,139.

## WORLD'S PRODUCTION.

The world's output of crude platinum in 1910 and 1911 is given approximately in the following table:

*World's production of crude platinum in 1910 and 1911, by countries, in troy ounces.*

| Country. | 1910 | 1911 |
|---|---|---|
| Russia | [a] 275,000 | [a] 300,000 |
| Canada | [a] 30 | [a] 30 |
| New South Wales | 332 | 470 |
| Colombia | 10,000 | [a] 12,000 |
| United States, domestic crude | 390 | 623 |
| United States, from foreign and domestic matte and bullion | [b] 1,000 | [b] 1,200 |
| Borneo and Sumatra | [a] 200 | |
| | 286,952 | 314,323 |

[a] Estimated. [b] Refined.

## SECONDARY PLATINUM.

Large quantities of platinum, probably amounting to at least one-third of the metal produced and imported into this country, are recovered as scrap or secondary platinum. It is practically impossible to obtain from the few refineries exact data as to the quantity of this secondary metal recovered.

## CONSUMPTION OF PLATINUM IN THE UNITED STATES.

It is not possible, owing to the peculiar conditions obtaining in the platinum industry, to obtain statements of stocks in hand at the various refineries, and the exact consumption can therefore not be stated. The apparent consumption is measured by the approximate production of refined metal in the United States, which was about 29,140 fine ounces, added to the imports of bars, unmanufactured metal, and manufactured products, amounting to approximately 91,600 fine ounces. The total apparent consumption was, therefore, 120,740 fine ounces, which is about one-half of the world's production of refined platinum. This estimate takes no account of the secondary platinum recovered from scrap.

## THE PLATINUM METALS.[1]

Six closely related metals are usually referred to as the "platinum group." They are platinum, iridium, osmium, ruthenium, rhodium, and palladium. According to their atomic weights, they fall into two groups, the first including ruthenium (101.7), rhodium (103), and palladium (107); the second group including osmium (191), iridium (193.1), and platinum (194.9). The atomic weight of gold (197.2) is close to that of platinum. In specific gravity the purified metals range as follows: Osmium, 22.48; iridium, 22.42; platinum, 21.48; ruthenium, 12.26; rhodium 12.1; palladium, 11.4.

In fusibility the order is as follows: Osmium is the most refractory of the metals, melting considerably above 2,000° C.; ruthenium, iridium, and rhodium follow in order; the fusion point of iridium is from 2,150° to 2,250° C. At 1,100° C. iridium begins to oxidize to a purple oxide. The melting point of platinum is 1,779° C. Palladium is the most fusible and melts at about 1,549° C., or at about the same temperature as wrought iron.

*Platinum.*—The mineral called platinum is really an alloy of platinum, iridium, rhodium, palladium, and often osmium, with varying amounts of iron, copper, and gold. It is usually found as small nuggets, scales, and rounded or irregular grains; its color is steel gray. The specific gravity of the crude platinum varies from 14 to 19. The percentage of platinum varies also within wide limits, but is generally from 70 to 85 per cent. The native platinum may be strongly magnetic or comparatively inert. The metal platinum is of grayish-white color and is hard, malleable, and ductile.

*Iridium.*—Iridium is generally present in crude platinum sand in alloy with osmium, as iridosmine, or more rarely in alloy with platinum as native metal. In its manufacture from crude platinum it is obtained as a sponge, which is then melted with the addition of a

[1] The following paragraphs are in part taken from Kemp, J. F., Geological relations and distribution of platinum and associated metals: Bull. U. S. Geol. Survey No. 193, 1902.

little phosphorus. Melted iridium is a brilliant white, brittle metal. Its hardness is 6.7, surpassing that of platinum.

*Osmium.*—Osmium occurs generally as an alloy with iridium, in which the other metals of the group are very subordinate. The mineral called iridosmine forms hexagonal crystals or flattened grains and has a white color considerably lighter than that of platinum. It contains from 40 to 77 per cent iridium and from 20 to 50 per cent osmium.

The metal in refined state is bluish gray, hard, and brittle and oxidizes rather easily.

*Palladium.*—Palladium is a white metal, intermediate in color between platinum and silver. Its hardness is about equal to that of platinum. It is malleable, ductile, and sectile, and dissolves easily in nitric acid. Palladium is present in almost all varieties of crude platinum, but the analyses rarely show more than 2 per cent. In larger quantities it is present in some copper ores, but its state of combination is in doubt. Probably it is combined with arsenic, like sperrylite.

*Rhodium.*—Rhodium is a white metal of the color of aluminum. It is ductile and malleable at red heat. The metal occurs in crude platinum in quantities up to 4 per cent. Like palladium, it probably occurs in combination with arsenic in certain copper ores.

*Ruthenium.*—Ruthenium is a white, hard, and brittle metal, which is scarcely attacked by aqua regia. Like osmium, it oxidizes rather easily in the air. It is found to small extent in crude platinum, but mainly occurs to the extent of a small percentage in the mineral iridosmine.

*Other platinum minerals.*—Very few platinum minerals are known beyond those already mentioned. Sperrylite or arsenide of platinum ($PtAs_2$), with a little antimony and rhodium, occurs as small crystals of an isometric form and tin-white color in certain copper and nickel ores—for instance, at Sudbury, Ontario, and at the New Rambler mine, Wyoming. The minute crystals are embedded in pyrrhotite or covellite.

Laurite is an extremely rare sulphide of ruthenium with a minor amount of osmium. It is known only from the platinum washings of Borneo.

Palladium in quantities up to 10 per cent also occurs in combination with gold. This mineral, called porpezite, has been described from Brazil, where it occurs in gold-bearing veins.

Platinum has been found in some varieties of tetrahedrite and bournonite. In minute quantities it occurs in some quartz veins, mainly of the so-called "high-temperature class," for instance, in northern Finland and in the gold-bearing veins of Beresowsk, Russia. Occasionally platinum is found in clay shales and in coal ashes, but so far not in recoverable quantities. Platinum is present in some meteorites and in the sun.

## DETERMINATION OF THE PLATINUM METALS.

The correct determination of platinum metals is somewhat difficult, and mistakes are often made by inexperienced chemists and assayers. It is difficult to say how much of the mistakes found in reports of new discoveries of platinum in the current press is due to such

inexperience and how much to deliberate fraud. The most ridiculous statements are often made. A statement was made, for instance, in 1911 of a discovery of an "immense bed of osmium ore near Boise, Idaho." The analysis was given as follows:

| | | |
|---|---|---|
| Gold | ounces per ton | 2.3 |
| Iridium | do | .1 |
| Osmium | do | 20.0 |
| Tungsten oxide | per cent | 5.0 |
| Tin | do | .25 |
| Cobalt | do | .5 |
| Nickel | do | 1.0 |

Other statements were current of a discovery of a rock containing tin and platinum near Merlin, Oreg. It was claimed to contain from 1 to 65 ounces of platinum per ton and said to occur "in a mineralized zone 600 feet wide, with 15 feet of spherulitic gangue and 8 feet of pitchblende." It is unfortunate that such statements should find even temporary credence.

The usual method of determining the platinum metals is by the crucible or scorifier assay and subsequent determination of the metals in the silver button.

By the old method the silver alloy first obtained in the regular course of assays is parted in strong sulphuric acid and the residual metal weighed. This is realloyed with silver in a second cupellation and parted in nitric acid, the residual metal being again weighed. Any difference shown between the two weighings is assumed to be and is called platinum. Sometimes it is so, and if any considerable amount of platinum be present there will be a decided difference between the two weighings; but a slight difference is no evidence whatever of the presence of platinum. On the other hand, the second weight may equal or possibly exceed the first, even when traces of platinum are present. Again, other members of the platinum group may go into solution in nitric acid. If present, these would be called platinum and escape detection. The method does not provide any direct tests whatever as to the presence or absence of platinum. It is often indecisive, and sometimes gives erroneous results. It is, therefore, quite unsatisfactory. * * * In the regular course of assaying gold is parted from silver by dissolving the silver in nitric acid. If platinum be present in small amounts only, it will readily go into solution in the nitric acid. If now a limited amount of hydrogen sulphide be added to the solution from parting, any platinum present will be precipitated as sulphide, along with some silver sulphide. On filtering off the precipitate (which generally is sufficiently washed by the operations necessary to transfer it from the precipitating dish to the filter), the moist filter is transferred to a small porcelain crucible, dried at a low heat, and burned off by gentle ignition. This transforms the sulphide precipitate into a metallic sponge, which is wrapped in a small piece of thin lead foil and cupelled. The resulting bead is then parted in strong sulphuric acid, when the platinum will be left as a dark residue, generally collected in spongy form, even when minute in quantity. This sponge, after reboiling in fresh acid, if necessary, is suitably washed by decantation, annealed, and weighed.

This excellent method, as quoted above, has been proposed by F. P. Dewey.[1] However, it does not take into account the possible presence of the other platinum metals. Osmium and iridium are always present, and it is well known that some copper ores contain more palladium than platinum. For exact determinations the crude platinum obtained must be separated according to standard analytical methods. Another method for the same purpose has been suggested by A. Steinmann.[2]

By using slightly diluted acid the silver can be extracted without loss of platinum. The following method is proposed. About 250 milligrams of platinum alloy are mixed

[1] The direct determination of small amounts of platinum in ores and bullion: Bull. Am. Inst. Min. Eng. No. 64, 1912, pp. 439–442.

[2] Swiss Pharmaco-Chemical Weekly, vol. 49, 1911, pp. 441–444, 453–457.

with silver (at least five times the quantity of platinum present), copper (a quantity equal to that of the platinum), and lead, cupelled at as high a temperature as possible and the residue fused for from 3 to 5 minutes. The resulting button is rolled to a thickness of 0.2 millimeter and heated for one-fourth of an hour with diluted sulphuric acid (100 volumes of concentrated acid to 22 volumes of water) at a temperature not exceeding 240° C. The treatment with acid is repeated twice, and the residual platinum is washed, dried, and weighed.

This method is of course open to the same objection as that noted in regard to Dewey's procedure.

L. J. Curtman and P. Rothberg have recently proposed [1] a new method for the detection of the platinum metals in which, however, the various elements of this group can not be distinguished. It is based on the glow reaction exhibited by finely divided platinum, palladium, rhodium, or iridium when passing over it a mixture of air and illuminating gas. The substance to be tested is brought into solution by any of the common methods and about 0.2 centimeter of the solution is absorbed into a piece of thin asbestos paper by alternately dipping the paper into the solution and heating until the required volume has been absorbed. The paper is now heated to redness in the flame and then removed, and while the paper is still warm it is brought into a stream of a mixture of illuminating gas and air from a Bunsen burner. If platinum or allied metals is present the paper will begin to glow. The glow must last for some time, and the effect can be repeated. The asbestos paper must be very thin. This test is sensitive to extremely small quantities of the metal, the limits being: Platinum, 0.002 milligram; palladium, 0.0005 milligram; rhodium, 0.0009 milligram; and iridium, 0.005 milligram. The presence of other substances does not interfere with the test.

## INFLUENCE OF IMPURITIES IN PLATINUM WARE.

It has long been known to chemists that certain kinds of platinum ware are more rapidly attacked by coal gas than others. A recent report of the Physikalisch-technische Reichsanstalt [2] deals with this subject. It appears that platinum containing 3.5 per cent of iridium separates carbon from coal gas very much more rapidly than pure platinum. Another test on two pieces of platinum which had been used under similar conditions, one of which had deteriorated rapidly while the other had not, gave as the only ascertainable difference 0.2 per cent of rhodium in the bad sample and 0.1 per cent in the good.

The general conclusion is that platinum containing iridium is more strongly attacked in a current of illuminating gas at 650° C. than pure platinum. A number of papers have lately appeared dealing with the quality and deterioration of platinum utensils. A preliminary report of a committee on quality of platinum laboratory utensils [3] was recently published, and its authors, W. F. Hillebrand, P. H. Walker, and E. T. Allen, present some interesting and valuable conclusions. They state that the quality of much, if not all, of the platinum ware made in this country in recent years is markedly inferior to that which was procurable many years ago. One cause for this is said to be the use of scrap platinum for laboratory utensils. The objections made to the inferior ware are (1) undue loss of weight on ignition,

[1] Jour. Am. Chem. Soc., vol. 33, May, 1911, pp. 718–723.
[2] Rept. Physikalisch-techn. Reichsanstalt on platinum: Zeitschr. Instrumentenkunde 30, 1910, p. 190.
[3] Jour. Indust. and Eng. Chem., vol. 8, No. 9, September, 1911.

(2) loss of weight of acid treatment, (3) alkalinity of the surface after ignition, and (4) development of cracks after continued heating. As causes for loss on ignition the presence of iridium and base metals is generally given. Loss on acid treatment after ignition is mainly due to a content of iron and calcium. After a thorough consideration of the subject, the occasionally strong contamination by iron, iridium, and other metals is given as the probable cause of most of the defects. Purchasers who desire ware of the highest quality should specify that it must not show marked uneven discoloration on heating, and must give no test for iron after prolonged ignition (two hours may be regarded as sufficient), and that the rate of loss of weight per hour at 1,100°C. over a period of not less than four hours and preferably longer, shall not exceed, say, 0.2 milligrams. Iridium is rather easily volatilized at high temperatures, especially above 1,100° C. Although the volatility of platinum is much less marked, it is not, at this temperature, a negligible factor.

## USES OF PLATINUM.

Owing to its high melting point and great resistance to acids, platinum is extensively used for laboratory utensils. Platinum salts are employed in chemical analysis. In the manufacture of sulphuric acid the metal was used in making large concentration kettles, but of late gold has been substituted for it. In photography, dentistry, and electric installation much platinum is used. Of late the manufacture of jewelry has consumed large quantities of it. It is extensively used for chains and for the setting of diamonds, the claim being made that, besides being more resistant than silver and harder than gold, the stones are better offset by platinum and appear larger than in any other kind of setting.

*Substitutes for platinum.*—The high price which platinum has attained during the last two years has necessitated the finding of substitutes for it. In the manufacture of sulphuric acid as well as in ware for chemical use gold is now often substituted for platinum. At one time much platinum was used in the manufacture of incandescent lamps, but it is now almost entirely replaced by tungsten; the osmium lamps had a similar fate when the price of that metal rose to extremely high figures. Platinum triangles, used extensively in laboratories, have recently been successfully displaced by similar appliances made of an alloy of nickel and chromium. Nevertheless, there remain so many industrial applications of platinum for which no substitutes can be found that it is not likely that the price will be much cheapened in the future.

The present extensive use of platinum in the manufacture of jewelry is unfortunate, as other metals could be substituted for it, and this fad is undoubtedly one of the principal causes of the great increase in the price of platinum.

## OCCURRENCE OF PLATINUM.

### UNITED STATES.

*California and Oregon.*—The principal occurrences of platinum in the United States are in California and Oregon, and the production of crude platinum is practically limited to these States. In California a small amount of platinum sand occurs in the principal placer mines

of the gold belt of the Sierra Nevada, but in no place is the metal so abundant that the deposit can be worked for platinum alone. The source of the metal is undoubtedly in the serpentine and peridotite or pyroxenite, which occur as intrusive masses throughout the gold belt. In many places small silvery white scales of iridosmine are more common than the platinum itself. Little or no platinum was recovered until the beginning of dredging operations on a large scale along the foothills of the mountains. In the black sand from the sluice boxes of the dredges the platinum metals accumulate, and the platinum sand is recovered by panning the black sand after the gold has been removed by amalgamation. The quantity of platinum recovered would only constitute a small fraction of a cent in value by the ton of sand treated, and its recovery would be out of the question except for the presence of gold. Platinum is now recovered at the dredges in Butte, Yuba, Sacramento, Calaveras, and Merced counties. The platinum occurs in very small scales and grains, as a rule somewhat finer than the gold which in the dredging fields generally passes through a 100-mesh screen. Day [1] and Kemp [2] have summarized the occurrences of platinum in California and Oregon.

Another region in which platinum is recovered includes the gold belt in northwestern California in Siskiyou, Trinity, Humboldt, and Del Norte counties. A few ounces are recovered annually in some of the placer mines in these counties. Serpentine and peridotite are abundant in this region and the platinum is undoubtedly derived from these rocks. As far as known there are no localities which contain enough platinum for profitable mining for this metal alone.

The presence of platinum is characteristic of the beach sands along the Pacific coast from San Bernardino County northward to the mouth of the Columbia. The principal beaches where platinum has been reported are Santa Barbara, Lompoc, Santa Cruz, and occasionally between Santa Cruz and the Golden Gate. The richest beaches are farther north in Humboldt and Del Norte counties and in Coos County, Oreg. Bullard in Coos County and Port Orford in Curry County have proved, perhaps, the richest beaches. It is very difficult to give the percentage of platinum occurring in the sand, as the fine scales are concentrated into very thin pay streaks on the beach. The determination by Day gives in some cases values as high as $1 or $2 per ton, but ordinarily much smaller values are reported, ranging from a few cents up to 20 or 30 cents. Some production is obtained annually from the beach placers in the vicinity of Port Orford. It has been proposed by D. T. Day and R. H. Richards to use the shaking table for the treatment of these low-grade sands, but thus far the results do not seem to have been satisfactory.

In the interior of Oregon platinum is widely distributed in the southwestern counties, including Josephine and Douglas counties. The richest places appear to be near Kirby, along Josephine, Connor, and Succor creeks, from which during 1911 platinum sands to the value of about $1,000 are said to have been recovered. It is certain, at any rate, that most of the sands are very poor in platinum.

---

[1] Day, D. T., Trans. Am. Inst. Min. Eng., vol. 30, 1900, p. 704; Day, D. T., and Richards, R. H., Black sands of the Pacific slope: Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, pp. 1175–1258.

[2] Kemp, J. F., Bull. U. S. Geol. Survey No. 193, 1902, p. 52. See also Ann. Repts. California State Mineralogist, as follows: Vol. 4, 1884, pp. 309, 311 (iridium, p. 231); vol. 8, p. 217, Humboldt County; p. 584, Siskiyou County; vol. 9, p. 717, Trinity County; vol. 12, p. 408, Trinity County.

*Possibility of new discoveries in California and Oregon.*—It seems very unlikely that any important discoveries of platinum sand will be made in the well-prospected gold-bearing districts. The presence of platinum along the whole coast of California shows that it has been transported from the adjacent land area and, as serpentine areas occur extensively in the coast ranges, it is well possible that within this mountainous district localities may yet be found which will prove richer in platinum than the occurrences thus far known.

The coast ranges have been prospected but little, as the larger part of them is entirely barren of gold-bearing deposits, and it may be well worth while to examine these districts by panning the gravels in order to ascertain whether any of these serpentine and peridotite areas may not contain more platinum than those occurring in the well-prospected gold-bearing areas. Although probably all peridotites and some pyroxenites contain a little platinum, yet it is evident that only in few places in the world does the metal occur in economically important quantities.

*Other States.*—The literature contains frequent mention of platinum in gold-bearing gravels in the States outside of California and Oregon. It has been reported from Arizona. In Colorado it is reported from Buena Vista in Chaffee County, Aspen in Pitkin County, Liberty in Saguache County, and Telluride in San Miguel County. In Idaho it is reported from the Payette River and Snake River sands, also at Rocky Bar, in Elmore County, at Elk City district in Idaho County, on North Fork of Clearwater River in Idaho County, and at Pierce City in Shoshone County. In Montana, according to D. T. Day, it is found in concentrates from Princeton in Granite County. In northeastern Oregon it occurs at Durkee in Baker County, and also, it is stated, near Sumpter; it is also mentioned as occurring in sands at Foster in Lynn County, at La Grande in Union County, and at Hillsboro in Washington County. In Utah it is reported at Hite in Garfield County. In Washington it is found on the beaches in Clallam County, and on Sand Island in Pacific County.

The occurrence of platinum in copper ores, mostly of pre-Cambrian age, in Wyoming and Nevada has already been mentioned. In these ores there is usually more palladium than platinum. Copper and gold bullion generally contains a small quantity of platinum metals, which is saved in some refining processes.

In the Eastern States platinum is rare but has been reported from Lumpkin County, Ga., from Maryland near Baltimore, and from Rutherford County, N. C. A nugget of platinum weighing 104 grams was once found in the glacial drift near Plattsburg, N. Y. It was intergrown with chromite.

## FOREIGN COUNTRIES.

*Central America, West Indies, and Mexico.*—Platinum sands are reported from Honduras and from the island of Santo Domingo. In Mexico platinum is evidently extremely rare, and no reliable data of its occurrence are available.

*Brazil.*—Platinum was observed at an early date in the gold washings of Minas Geraes, but very little, if any, of the metal has actually been recovered.

*Borneo.*—Platinum was discovered in 1831 in the gold washings of southeastern Borneo in gravels derived from serpentine, diorite,

and gabbro. The rare mineral laurite, a sulphide of ruthenium and osmium, was discovered at this place. The locality has yielded a production of at least a few thousand ounces.

*Australia.*—New South Wales contributes a few hundred ounces of platinum sands annually from gravels at Fifield near Parks, and a small quantity is also obtained from beach sands in some of the north coast districts. The total production is 11,578 ounces. In 1911 the production was 470 ounces, an increase of 138 ounces compared with the production of the previous year. Most of it came from Fifield. The shafts to bedrock are 50 to 60 feet deep and the thin pay streak on the bedrock yields 1 part of gold to 7 parts of platinum.

The presence of platinum in Tasmania has been known for some time, but no production has been reported. Lately, however, iridosmine has been reported from gravels about 20 miles from Waratah. The quantity obtained during three months in 1910 was 38 ounces.

*Russia.*—About 95 per cent of the platinum in the world is derived from five districts in the Ural Mountains of Russia. The platinum is derived from creek and river gravels from localities in the vicinity of intrusions of peridotite and pyroxenite in crystalline schists. Not all of these localities are equally productive. To a considerable extent the production is obtained from small workings by hand labor, but lately dredges have been installed which are able to handle the poorer grades of materials. The average yield is said to be about 0.07 ounce per metric ton of gravel. The washings are both on the European and on the Asiatic side of the range. The largest production comes from the southern Verchotur district, in which the production of 1911 was 121,300 ounces, representing an increase of about 10,000 ounces over 1910. The adjoining northern Verchotur district produced 11,375 ounces. In the Perm district the production during 1911 was 46,873 ounces. The output in the Ekaterinburg districts was small, as was that of the Tcherdinsk district.

The official figures of the production for 1911 are 180,400, but it is well known that the actual production is considerably higher. It is estimated to 300,000 ounces. The production of iridosmine according to official figures is about 60 to 70 ounces per annum, but this probably represents only a small fraction of the actual production of this rare mineral.

The official and the estimated actual production in Russia since 1900 are as follows:

*Production of platinum in Russia, in fine ounces.*

| Years. | Official. | Estimated total. |
|---|---|---|
| 1900 | 163,060 | 212,500 |
| 1901 | 203,057 | 315,200 |
| 1902 | 197,024 | 300,000 |
| 1903 | 192,976 | 226,000 |
| 1904 | 161,950 | 290,120 |
| 1905 | 167,950 | 200,450 |
| 1906 | 185,792 | 210,318 |
| 1907 | 172,752 | 310,000 |
| 1908 | 156,792 | 250,000 |
| 1909 | 164,118 | 264,000 |
| 1910 | 175,716 | 275,000 |
| 1911 | 180,400 | 300,000 |

It will be seen from these figures that in spite of the phenomenal increase in price the production has increased but very little; in fact, according to the official figures, the production was larger in 1901, 1902, and 1903 than it is at present. The platinum production of Russia is said to be controlled by a French corporation called Société Anonyme d'Industrie du Platine. This company controls a number of the larger producers, but there are also a considerable number of independent miners. Almost all of the platinum produced in Russia is refined abroad, in London, by Johnson, Matthey & Co.; in Germany, by Heraeus & Co. (Hanau), and in the Norddeutsche Affinerie at Hamburg; in Paris, by Quennesseu, de Belmont, Legendre & Co.

It is possible that new discoveries of platinum-bearing sands will be made in the region separating the districts now worked from the Arctic Ocean, but so far no such discoveries have been reported. It can scarcely be doubted that the platinum-bearing gravels thus far known are approaching exhaustion. Nothing definite seems to have resulted from the proposal of two years ago that the export of crude platinum be prohibited and that the metal be refined in domestic laboratories.

The geological structure of the platinum-bearing region has recently been described by Louis Duparc.[1]

Platinum occurs at various places in Siberia, beyond the Urals, but no production is reported from these places.[2]

*Colombia.*—The production of platinum in Colombia is slowly increasing and quite recently the Lozana and other platinum mines have been purchased by the Anglo-Colombian Development Co.[3] Platinum was recognized by the Spaniards in 1735 in the auriferous sands of the rivers of Choco and Barbacoas. As well known, the metal was first discovered in material from Colombia. In 1788 the miners were paid the sum of 2 pesos per pound of the metal, which was then being largely used in jewelry and in the manufacture of crucibles. At the end of 1788 there had been collected from Choco 3,820 Spanish pounds. In 1824 the annual production from the Choco is said to have amounted to about 1,000 pounds. In 1819 platinum was discovered in the Ural Mountains, and the Colombian production became reduced, while that of Russia increased rapidly.

The principal placers in the running streams are situated on the western slope of the western Cordillera near the divide separating the Atrato from San Juan River. The material is formed of sand, pebbles, and bowlders bound together by clay, and this rests on indurated clays with sand. The present drainage has cut into this material and concentrated the gold and platinum in the river gravels. In many places in Colombia the gold is associated with a little platinum. The platinum has a wide range in Colombia, extending between the second and the sixth degrees of north latitude. A specimen of platinum from Barbacoas contains as follows: Platinum, 89.02 per cent; iron, 5.00 per cent; rhodium, 3.46 per cent; palladium, 1.06 per cent; iridum, 1.46 per cent; copper, traces.

Chromite is present in the sand with the platinum, which points to a peridotite as its original home.

---

[1] Le Platine et les gîtes platinifères de l'Oural: Arch. sci. phys. et nat., vol. 31, March, April, May, and June, 1911.
[2] Hautpick, E. de, Min. Jour., London, Feb. 4, 1911.
[3] Min. Jour., London, Apr. 20, 1912.

The production of platinum from Colombia is difficult to ascertain. The quantity imported into the United States in 1911 was 6,371 troy ounces of the crude sand, valued at $202,611. The total production for the same year was probably about 12,000 troy ounces.

*British Columbia.*—The presence of platinum metals in British Columbia has been known since 1887. The upper branches of Similkameen River are known to contain platinum, especially the North Fork, usually referred to as the Tulameen River. A considerable production was at one time maintained from these gold and platinum bearing placer deposits.[1] Camsell estimates the total production of crude platinum from this district at 9,860 ounces. The richest platinum ground was found on Tulameen River between the mouths of Slate and Champion creeks. On Tulameen River no platinum was found above the mouth of Champion Creek, and below Slate Creek the grains became finer and the quantity gradually decreased. The platinum in some cases was present in a ratio of 1 to 3 by weight as compared to gold. During 1911 active prospecting has been carried on, and it is stated that workable ground has been discovered. Dredging is the process which it is intended to apply to the deposit. During the last few years the annual production of platinum from some of these placers has amounted to only a few ounces. Statements in the press are to the effect that the depth to bedrock averages 12 feet. A company organized in Vancouver has leased some 20 miles of Similkameen and Tulameen rivers from the Government. The production for 1911 is estimated at 30 ounces. Much of the gold and platinum in this district is coarse and the nuggets have not traveled far from their original source. Much of the gold is still embedded in quartz, while the platinum is often associated with chromite, olivine, and pyroxene. Kemp mentions platinum intergrown with olivine and octahedral chromite from the district. One of these specimens shows the contemporaneous development of the three minerals very clearly. The rock from which the platinum was derived is probably a belt of basic intrusives, mainly peridotite, having a flanking border of pyroxenite. Kemp concluded that the original source of the platinum was in both the peridotite and the pyroxenite, and this conclusion is corroborated by Camsell. The heavy minerals associated with platinum, besides those mentioned, are magnetite and native copper. An analysis of the crude platinum gave, according to G. C. Hoffman, quoted by Camsell, the following results:

| | | | |
|---|---|---|---|
| Platinum | 72.07 | Copper | 3.39 |
| Palladium | 0.19 | Iron | 8.59 |
| Rhodium | 2.57 | Osmiridium | 10.51 |
| Iridium | 1.14 | Gangue | 1.69 |
| Osmium | | | 100.15 |

Kemp assayed a number of specimens of platinum-bearing rocks, such as serpentine, chromite, pyroxenite, and peridotite, from this district and found in most of them traces of platinum. Some selected chromite gave half an ounce of platinum per ton. Other samples contained from 0.1 to 0.3 per cent of the metal. It is

[1] Camsell, Charles, Platinum mining in the Tulameen district: Jour. Canadian Min. Inst., vol. 13, 1910.

exceedingly improbable, however, that valuable deposits of platinum will be found in the parent rock.

Reports were current during 1911 of a discovery of platinum metals at and near the Granite-Poorman mining property, a few miles from Nelson. A well-defined dike bearing these metals is said to have been traced for several miles in the general direction of Fortynine Mile Creek and across Kootenai River. A statement is made by E. Jacobs in the Canadian Mining Journal of September 1, 1911, that the rock containing the platinum metals is serpentine and probably an altered peridotite. The predominant metal is said to be palladium, though platinum and other allied metals are also said to occur. Whether the find is of economic importance is not certain. The existence of a new metal named canadium has been reported in this serpentine rock, but the discovery has not been confirmed.

The occurrence of platinum in small quantities has been mentioned from near Edmonton on the North Saskatchewan in Alberta and from Yukon River at the mouth of Teslin and Lewes rivers in the Northwest Territory.

The pre-Cambrian copper and nickel ores of Sudbury, Ontario, contain a small percentage of platinum, palladium, rhodium, and ruhenium, some of which is saved in refineries located in the United States.

## IRIDIUM.

*Uses.*—The properties of iridium are briefly indicated on a preceding page. Owing to its unique qualities, iridium finds a fairly extensive use. Most of the metal produced is probably used for the purpose of hardening platinum, the percentage of iridium in the alloys ranging from 5 to 20 per cent. Up to 10 per cent of the alloys are ductile and malleable; those containing from 10 to 20 per cent of iridium are hard and difficult to work; where the alloy contains 30 per cent of iridium, it is no longer attacked by aqua regia. Iridium is further used for various scientific and technical purposes, such as standard weights, pivots, contact points, and fountain-pen points. For certain high-temperature experiments (above 1,600° C.) iridium is rolled in sheets and welded into tubes. Pure iridium is difficult to work on account of its brittleness. Iridium black, an oxide of the metal, is highly valued as a pigment for decorating chinaware.

*Production, imports, and prices.*—The source of iridium is the small amount contained in native platinum, averaging perhaps 1.5 per cent, and, further, the small quantities of iridosmine and native iridium recovered in the placers, regarding which there is no reliable statistical information. Only small amounts of iridium are contained in copper bullion. The world's production of pure iridium is probably not more than 5,000 ounces a year, of which perhaps about 500 ounces are recovered in the United States, mostly from imported platinum sand and from copper ores and bullion.

According to the Bureau of Statistics, 3,905 troy ounces of "iridium and iridium in native combination with platinum metals," valued at $210,616, or about $54 per troy ounce, were imported into the United States in 1911. The price has been increasing rapidly, and in 1911 it ranged from $60 to $64 per ounce for pure metal.[1]

[1] Eng. and Min. Jour., Jan. 6, 1912, p. 4.

### OSMIUM.

*Uses, production, and imports.*—No data are available as to the production of osmium. There is no great demand for this metal, which formerly was somewhat extensively used for the manufacture of incandescent lamps. It is believed that rather large stocks of osmium are carried in Europe. Of "osmium and native combination with platinum," 576 troy ounces were imported into the United States in 1911, valued at $25,476, or $44.23 per ounce.

### PALLADIUM.

*Uses, production, and imports.*—Palladium finds a fairly large use in technology. Circles of astronomical instruments are made of it, and it is also employed in watchmaking. Its most extensive use is probably for certain alloys in dental work. It is also employed for soldering platinum metals. The demand for this metal is considerably greater than the supply. The metal is not altered or discolored by exposure to air or hydrogen sulphide, hence it is often used for plating metal ware.

Native platinum contains variable amounts of palladium, which, however, probably average considerably less than 1 per cent. Assuming a world's annual production of 300,000 ounces of crude platinum and an average recovery of 0.7 per cent of palladium, the total quantity available from this source would be about 2,100 troy ounces. It is an interesting fact that palladium occurs in certain copper ores and in copper bullion from some localities in much larger quantities than in the crude platinum sands (see p. 4), and such ores and bullion should be carefully tested for this valuable metal. The production of palladium from crude foreign and domestic sands in the United States was probably not over 300 ounces, but the quantity recovered in several refineries from bullion and ores amounted to 2,090 fine ounces, an estimated total production of palladium in the United States for 1911 of 2,390 ounces, of which about two-thirds probably was derived from domestic sources. It is likely that the production of palladium in the United States will increase during the next few years.

According to the Bureau of Statistics, 1,218 troy ounces of palladium were imported into the United States in 1911, the value assigned being $56,307, or $46.22 per ounce. The apparent consumption of palladium in the United States in 1911 would therefore be 3,808 ounces. In 1911 the price of palladium was quoted at $1.75 per gram, or about $55 per troy ounce.

### RHODIUM.

Rhodium, owing to its malleability and its high melting point, is used to some extent for thermo elements in high temperature determinations, and also for laboratory utensils of various kinds. The thermo elements consist of pure platinum and platinum alloyed with 10 per cent rhodium.

The analyses of crude platinum show that rhodium is contained in it in considerable quantities, averaging perhaps 2 per cent. It is therefore clear that there must be considerable stocks of this metal in Europe, and that its present price, $5 per gram or $155

per troy ounce, is not caused by its scarcity. With an assumed average content of rhodium of 2 per cent, the possible production, assuming a world's production of 300,000 ounces of crude platinum, would be about 6,000 fine ounces. There were no imports in 1911. A little rhodium is produced in the United States, partly from platinum sand and partly from Canadian and other copper bullion.

### RUTHENIUM.

There are few if any uses for ruthenium, for it is easily oxidized and brittle, being in this respect similar to osmium. Ruthenium, to the extent of several per cent, seems to be contained mainly in the mineral iridosmine, but it also occurs in copper ores from Sudbury and other places.

# INDEX.


A.

Page.

Abrasive materials, summary ..... 99
Acid, open-hearth steel ..... 166
Adirondack district, iron ore ..... 126
Africa, chromite ..... 980
  copper ..... 313
  gold ..... 215
  iron ore ..... 140
  lead ..... 320
Alabama, bauxite ..... 923
  cooperation ..... 8
  gold ..... 211, 223, 232
    silver, copper, lead, and zinc (mine production) ..... 877
  iron ore ..... 122
  manganese ore ..... 192
  pig iron ..... 154
  silver ..... 211, 223, 232
  value of mineral products ..... 12, 17
  wavellite ..... 937
Alaska, copper ..... 256, 267, 276
  gold ..... 211, 223, 225
    silver, copper, lead, and zinc (mine production), by A. H. Brooks ... 406
  lead ..... 320
  quicksilver ..... 916
  silver ..... 211, 223, 225
  tin ..... 963
  tungsten ..... 941
  value of mineral products ..... 12, 18
Algeria, iron ore ..... 137, 140
Alizarin, imports, summary ..... 111
Aluminum ..... 932
  (*See also* Bauxite and aluminum.)
  alloys ..... 934
  applications of metallic aluminum ..... 936
  bibliography ..... 938
  exports ..... 110, 932
  manufacture of metallic aluminum ..... 932
  patents ..... 932
  prices ..... 933
  curve showing price by months ..... 935
  market ..... 933
  production and consumption ..... 932
  salts, production ..... 937
    imports ..... 937
    new source of ..... 937
  summary ..... 94
Alunite ..... 924
American Iron and Steel Association ..... 104
  statistics of pig iron and steel .. 154, 156, 158, 165
Analyses, bauxite ..... 929
  tungsten steel ..... 945

Page.

Aniline salts, summary ..... 111
Animikie range, iron ore ..... 132
Anthracite ..... 111
Antimonial lead, summary ..... 93, 322
Antimony, by Frank L. Hess ..... 973
  consumption ..... 975
  imports ..... 974
  prices ..... 975
  production ..... 973
  salts, imports ..... 974
  secondary antimony ..... 975
  summary ..... 95
Argentina, copper ..... 313
  gold ..... 215
  tungsten ..... 944
Arizona, copper ..... 256, 267, 277
  gold ..... 211, 223, 225
    silver, copper, lead, and zinc (mine production), by V. C. Heikes .... 420
  lead ..... 320
  platinum ..... 997
  quicksilver ..... 890, 898
  silver ..... 211, 223, 226
  tungsten ..... 941
  value of mineral products ..... 12, 19
  vanadium ..... 949
  zinc ..... 355
Arkansas, bauxite ..... 923, 926
  lead ..... 320
  manganese ore ..... 192
  manganiferous ore ..... 197
  silver, copper, lead, and zinc (mine production), by J. P. Dunlop ..... 798
  value of mineral products ..... 13, 20
  zinc ..... 355
Arsenious oxide, summary ..... 100, 111
Asbestos, summary ..... 102, 111
Ashland, shipments of iron ore ..... 133
Ashtabula, Ohio, receipts of iron ore ..... 135
Asphalt, summary ..... 102, 111
Antikoken range, iron ore ..... 132
Australasia, copper ..... 309
  gold ..... 215
Australia, chromite ..... 980
  copper ..... 313
    imports from ..... 309
  iron ore, production ..... 140
  lead ..... 335, 343
  manganese ore ..... 196
  platinum ..... 998
  tin ..... 971
  tungsten ..... 944
  zinc ..... 370, 377

Page.

Austria, copper ... 313
exports to ... 310
quicksilver ... 917
tungsten ... 944
zinc ... 377,386
Austria-Hungary, gold ... 215
iron ore ... 140
lead ... 335,343
manganese ore ... 196

B.

Banka and Billiton, tin ... 971
Baraboo range, iron ore ... 132
Barium compounds ... 111
Barytes, summary ... 101,111
Basic pig iron, production ... 158
steel ... 166
Bauxite and aluminum, by W. C. Phalen ... 923
analyses ... 929
consumption ... 924
imports ... 924
method of purifying ... 931
new source of alumina ... 924
notes on deposits ... 926
prices ... 923
production, by States ... 923
summary ... 94
uses ... 929
world's production ... 924
Belgium, chromite ... 980
copper, exports to ... 310
iron ore ... 140
imports from ... 137
lead ... 335,343
manganese ore ... 196
imports from ... 195
zinc ... 377,386
Bessemer pig iron, production ... 158
steel ... 165,166
Billiton, tin ... 971
tungsten ... 944
Birmingham district, iron ore ... 126
Bismuth, by Frank L. Hess ... 976
imports ... 976
prices ... 976
production ... 976
summary ... 95
Blast furnaces, by States ... 156
Bolivia, copper ... 313
gold ... 215
tin ... 971
tungsten ... 944
Borax, summary ... 100,111
Borneo, platinum ... 990,997
Bosnia, chromite ... 985
manganese ore ... 196
Brazil, gold ... 215
manganese ore ... 195,196,208
platinum ... 997
quicksilver, exports to ... 919
tungsten ... 944
British Columbia, lead imports ... 337
platinum ... 1000
zinc ... 380
British East Indies, gold ... 215
manganese ores, imports from ... 195

Page.

British Guiana, gold ... 215
British North America, copper, exports to ... 310
imports from ... 309
lead, imports from ... 337
British South Africa, iron ore, imports from ... 137
Bromine, summary ... 100
Brooks, A. H., paper on gold, silver, copper, lead, and zinc in Alaska (mine production) ... 406–420
Buffalo, N. Y., receipts of Lake Superior iron ore ... 135
Burchard, Ernest F., paper on iron ore, pig iron, and steel ... 119–174
on manganese ore ... 191–208
Burrstones and millstones, summary ... 111
Butler, B. S., paper on copper ... 255–313
on silver, copper, lead, and zinc in Central States (Michigan) ... 811

C.

Cadmium, by C. E. Siebenthal ... 399–401
imports ... 400
prices ... 401
production ... 399
in Germany ... 400
summary ... 96
Calcium chloride, summary ... 100
California, chromite ... 979
copper ... 256,267,287
gold ... 211,223,226
silver, copper, lead, and zinc (mine production), by C. G. Yale ... 462
iron ore ... 122
lead ... 320
manganese ore ... 192
pig iron ... 154
platinum ... 995
quicksilver ... 890,899
silver ... 211,223,227
tin ... 966
tungsten ... 941
value of mineral products ... 122
zinc ... 355
Canada, chromite ... 980,985
cobalt ... 959
copper ... 313
exports to ... 310
imports from ... 309
production ... 313
gold ... 215
iron ore ... 140
imports from ... 137
lead ... 320,335,343
bounty ... 349
manganese ore, imports from ... 195
nickel ... 956
platinum ... 1000
quicksilver, exports to ... 919
rhodium ... 1003
ruthenium ... 1003
zinc ... 355,369
ore, imports from ... 380
Cape Colony, copper ... 313
Caucasus, manganese ore ... 203
Cement, summary ... 97

Page.

Central America, gold 215
lead 320
platinum 997
quicksilver, exports to 919,920
Charcoal pig iron, production 158
Chattanooga district, iron ore 126
Chile, copper 313
imports from 309
gold 215
lead 338
China, gold 215
iron ore 137,140
manganese ore 196
tin 971
Chosen (Korea), gold 215
quicksilver, exports to 919
Chromic iron ore, by W. C. Phalen 979
alloys of, and cobalt 959,985
ferrochromium 92,110,161
imports 980
notes on ore 980
distribution 981
sources 980
ore industry 983
prices 979
production 979
summary 94
uses 985
world's production 985
Clay products, summary 98
Cleveland, Ohio, receipts of iron ore 135
Coal, summary 96,111
bunker 112
Coal briquets, summary 96
Coal-tar products, summary 111
Cobalt (*see also* Tungsten, Nickel, etc.) 959
alloys of, and chromium 959
imports 959
production 959
summary 95,101,111
Coke, summary 97,111
Colombia, gold 215
iron ore 137
platinum 999
quicksilver, exports to 919
Colorado, bismuth 976
cadmium 399
copper 256,267,290
gold 211,223,228
silver, copper, lead, and zinc (mine production), by Charles W. Henderson 505
iron ore 122
lead 320
manganiferous iron ore 197
silver ore 197
molybdenum 955
pig iron 154
platinum 997
silver 211,223,228
tungsten 941
uranium 952
value of mineral products 12,23
vanadium 949
zinc 355
Conneaut, Ohio, Lake Superior iron ore, receipts 135

Page.

Connecticut, gold, silver, etc 878
iron ore 122
pig iron 154
tin 967
value of mineral products 13,24
Copper, by B. S. Butler 255-313
casting copper 306
condition of industry 256
consumption 310
electrolytic copper 307
exports, by countries 310
geological classification of copper deposits 257
imports by countries 309
Lake copper 306
ore 271
tonnage, by States 272,274
yield 274
prices 312
production 262
from 1845 to 1911 262
by principal districts 270
by States 256,267,269
mine returns 266
refinery 306
refined copper, total 307
review, by States 275-306
secondary 307
smelter and mine 267
smelter returns 264
smelting plants 264
sulphate 308
tonnage and yield of ores 271
stocks 309
summary 93
of statistics 256
uses 311
value 262
in gold and silver, per ton 272
world's production 312
Cornwall, tin 971
Corundum and emery, summary 99
Costa Rica, quicksilver, exports to 919
Crucible steel 166
Cryolite, summary 100
Cuba, chromite 980
copper 313
imports from 309
iron ore 139,140
imports from 137
manganese ore 195
quicksilver, exports to 919
Cuyuna Range, iron ore 132,135


D.


Delaware, value of mineral products 13,25
Director of the Mint 212
District of Columbia, value of mineral products 13,25
Dominican Republic, quicksilver, exports to 919
Duluth, shipments of iron ore 133
Dunlop, J. P., paper on silver, copper, lead and zinc in the Central States 793-872
Dutch East Indies, gold 215
Dutch Guiana, gold 215
quicksilver, exports to 919

E.

Page.

Ecuador, gold ..... 215
quicksilver, exports to ..... 919
Egypt, iron ore, imports from ..... 137
Electric smelting of iron ore ..... 161
publications ..... 164
Emery, summary ..... 99
England, cadmium ..... 399
copper ..... 313
lead ..... 335
quicksilver ..... 918
tungsten ..... 944
Erie, Pa., receipts of Lake Superior iron ore. 135
Escanaba, shipments of iron ore ..... 133
Exports, aluminum ..... 110, 932
asphalt ..... 112
clay products ..... 112
coal ..... 112
coke ..... 112
copper ..... 110, 310
fertilizers ..... 112
gold ..... 112, 218
iron ore ..... 138, 110
pig (including scrap) ..... 110
lead ..... 110, 338
lime ..... 111
marble and stone ..... 112
metals ..... 110
nickel ..... 110, 958
nonmetals ..... 112
petroleum ..... 112
paraffin ..... 112
platinum ..... 990
quicksilver ..... 110, 919
salt ..... 112
silver ..... 112, 218
sulphur ..... 112
zinc ..... 110, 382
foreign ..... 383
oxide ..... 112, 382

F.

Fairport, Ohio, receipts of Lake Superior iron ore ..... 135
Federated Malay States, tin ..... 971
tungsten ..... 944
Feldspar, summary ..... 102
Ferrochromium, summary ..... 92, 110, 161
Ferromanganese (*see also* Manganese ore) .. 92, 158
imports ..... 110, 161, 200
prices ..... 199
production ..... 199
summary ..... 92, 110
Ferromolybdemum, summary ..... 92, 110, 161
Ferrophosphorus, summary ..... 92, 110, 161
Ferrosilicon ..... 92, 110, 158
Ferrotitanium, summary ..... 92, 110, 161
Ferrotungsten ..... 92, 110
Ferrovanadium, summary ..... 92, 110, 161
Fertilizers, summary ..... 102
Fibrous talc, summary ..... 104
Finland, gold ..... 215
Flint pebbles, summary ..... 104, 111
Florida, value of mineral products ..... 12, 26
Fluorspar, summary ..... 100
Forge and foundry iron, production ..... 158

Page.

France, bauxite ..... 924
chromite ..... 980
copper, exports to ..... 310
gold ..... 215
iron ore ..... 140
lead ..... 335, 343
manganese ore ..... 195, 196
tungsten ..... 944
zinc ..... 377, 386
French Africa, iron ore ..... 137
French Guiana, gold ..... 215
French Indo-China, tungsten ..... 944
French West Indies, manganese ore ..... 208
Fuller's earth, summary ..... 102, 111
Furnace flux, summary ..... 99

G.

Garnet (abrasive), summary ..... 99
Gems and precious stones, summary ..... 102, 111
Georgia, bauxite ..... 923, 928
cooperation ..... 8
copper ..... 256, 267
gold ..... 211, 223, 232
silver, copper, lead, and zinc in Eastern States (mine production) ... 878
iron ore ..... 122
lead ..... 320
manganese ore ..... 192
pig iron ..... 154
platinum ..... 997
silver ..... 211, 223, 232
value of mineral products ..... 13, 27
Germany, cadmium ..... 400
chromite ..... 980
copper ..... 313
exports to ..... 310
imports from ..... 309
gold ..... 215
iron ore ..... 140
imports ..... 137
lead ..... 335, 343
imports from ..... 337
manganese ore ..... 195, 196
tungsten ..... 944
zinc ..... 377, 386
Gerry, C. N., paper on gold, silver, copper, lead, and zinc in Idaho (mine production) ..... 570
Washington (mine production) ..... 778
Glass sand, summary ..... 98
Gogebic range, iron ore ..... 132
Gold, silver, copper, lead, and zinc in the United States ..... 209
prefatory note ..... 209
Gold and silver, paper by H. D. McCaskey. 211-254
copper ore ..... 237, 245, 248
distribution, by States and sources of gold production of 1911 ..... 241
of silver production of 1911 ..... 246
by methods of treatment ..... 242, 247, 249
percentage of output by processes .... 252
by States and Territories in 1911 ..... 211
dry and siliceous ore ..... 237, 245, 248
exports ..... 218
imports ..... 218

Page.
Gold and silver, increase and decrease, by States ... 212
industry, by States ... 225
lead ore ... 237, 245, 249
mines—
number of ... 234, 236
report ... 219
method of collecting statistics ... 219
comparison of mint report and mines report ... 221
production of gold and silver reported from mines ... 222
by States and Territories ... 223, 225
ore production, classification, and average values ... 236
placers ... 242, 243, 247
price of silver ... 213
production by States in 1911 ... 211
since 1792 ... 217
since 1880 ... 218
silver, average tenor of, in ores, by mining districts ... 240
summary ... 93
tonnage ... 238
units of measurement ... 222
value, average, per ton of ore ... 237
world's production of gold ... 213
zinc ore ... 237, 246
Gold, silver, copper, lead, and zinc in the Eastern States in 1911 (mine production), by H. D. McCaskey ... 873–888
mining industry, by States ... 877
production ... 873
Gold, silver, copper, lead, and zinc in the Western States in 1911 (mine production) ... 403–792
introduction, by H. D. McCaskey ... 403
Alaska, by A. H. Brooks ... 406
Arizona, by V. C. Heikes ... 420
California, by Charles G. Yale ... 462
Colorado, by Charles W. Henderson ... 505
Idaho, by C. N. Gerry ... 570
Montana, by V. C. Heikes ... 602
Nevada, by V. C. Heikes ... 646
New Mexico, by Charles W. Henderson ... 702
Oregon, by Charles G. Yale ... 721
South Dakota, by Charles W. Henderson ... 734
Texas, by Charles W. Henderson ... 739
Utah, by V. C. Heikes ... 740
Washington, by C. N. Gerry ... 778
Wyoming, by Charles W. Henderson ... 788
Granite, summary ... 111
Graphite, summary ... 102
Great Britain, chromite ... 980
copper, exports ... 310
imports ... 309
production ... 313
gold ... 215
iron ore ... 140
imports from ... 137
lead ... 335, 343
tungsten ... 944
zinc ... 377, 386
Greece, chromite ... 980, 985
iron ore ... 140
imports from ... 137
Greece, lead ... 335
manganese ore ... 196
Grindstones, summary ... 99
Gypsum, summary ... 98

H.

Heikes, V. C., gold, silver, copper, lead, and zinc in Arizona (mine production) ... 420
Montana (mine production) ... 602
Nevada (mine production) ... 646
Utah (mine production) ... 740
Henderson, Charles W., gold, silver, copper, lead, and zinc in Colorado (mine production) ... 505
New Mexico (mine production) ... 702
South Dakota (mine production) ... 734
Texas (mine production) ... 739
Wyoming (mine production) ... 788
Herzegovina, manganese ore ... 196
Hess, Frank L., paper on antimony ... 973
bismuth ... 976
selenium ... 977
tin ... 963
tungsten, nickel, cobalt, vanadium, molybdenum, titanium, uranium, tantalum ... 941
Holland—
lead ... 343
zinc ... 377, 386
Honduras, quicksilver, exports to ... 919
Hones, oilstones, summary ... 99, 111
Hungary, copper ... 313
manganese ore ... 196
Huron, Ohio, receipts of iron ore ... 135

I.

Idaho, cobalt ... 959
copper ... 256, 267, 290
gold ... 211, 223, 229
silver, copper, lead, and zinc (mine production), by C. N. Gerry ... 570
lead ... 320
platinum ... 997
quicksilver ... 904
silver ... 211, 223, 229
tin ... 967
tungsten ... 941
value of mineral products ... 12, 29
zinc ... 355
Illinois, cooperation ... 8
lead ... 320
pig iron ... 154
steel ... 165
silver ... 211, 223, 229
silver, copper, lead, and zinc (mine production), by J. P. Dunlop ... 801
spiegeleisen ... 158, 199
value of mineral products ... 12, 31
zinc ... 355
Illustrations:
FIGURE 1. Curves showing value of mineral products in United States, 1880–1911 ... 109
2. Curves showing production of iron ore, pig iron, and steel, 1870–1911 ... 121

Page.

Illustrations—Continued.
FIGURE 3. Curve showing production of pig iron in United States in 1907–1911, by months ..... 157
4. Map showing iron ore reserves of Michigan in 1911 ..... 175
5. Diagram showing lead production ..... 318
6. Average weekly price of lead in 1906 and 1907 ..... 346
7. Average weekly price of lead in 1908 and 1909 ..... 347
8. Average weekly price of lead in 1910 and 1911 ..... 348
9. Curves of spelter production and consumption, 1873–1911. 357
10. Average weekly price of spelter in 1906 and 1907 ..... 390
11. Average weekly price of spelter in 1908 and 1909 ..... 391
12. Average weekly price of spelter in 1910 and 1911 ..... 392
13. Flow sheet of Leadville ore ... 547
14. Flow sheet of Bingham ore ... 767
15. Flow sheet of Park City ore ... 772
16. Curve showing price of aluminum, 1911, by months ..... 935
Imports, alizarin ..... 111
aluminum salts ..... 110, 937
aniline salts ..... 111
antimony ..... 110, 974
salts ..... 110, 974
arsenic sulphides ..... 111
asbestos ..... 111
asphalt ..... 111
barium compounds ..... 111
barytes ..... 111
bauxite ..... 110, 924
bismuth ..... 110, 976
borax ..... 111
burrstones ..... 111
cadmium ..... 110, 400
cement ..... 111
chromite ..... 110, 980
clay ..... 111
clay products ..... 111
coal ..... 111
coal-tar products ..... 111
cobalt oxide ..... 111, 959
coke ..... 111
copper ..... 110, 309
corundum ..... 111
cryolite ..... 111
ferrochrome ..... 110, 161
ferromanganese ..... 110, 161, 200
ferromolybdenum ..... 110, 161, 955
ferrophosphorus ..... 110, 161
ferrosilicon ..... 110, 161
ferrotitanium ..... 110, 161, 954
ferrotungston ..... 110, 161, 948
ferrovanadium ..... 110, 161, 951
fertilizers ..... 111
flint pebbles ..... 111
fluorspar ..... 111
fuller's earth ..... 111

Page.

Imports, gems and precious stones ..... 111
gold ..... 112, 218
granite ..... 111
graphite ..... 111
grindstones ..... 111
guano ..... 111
gypsum ..... 111
hones, whetstones ..... 111
infusorial earth ..... 111
iridium ..... 110, 1001
iron ore ..... 110, 137
kaolin ..... 111
lead ..... 110, 337
paints ..... 111
lime ..... 111
magnesite ..... 111
manganese ore ..... 110, 195
by customs districts ..... 195
marble and stone ..... 111
metals ..... 110
mica ..... 111
mineral waters ..... 111
monazite ..... 111
nickel ..... 111
nonmetals ..... 111
ocher ..... 111
osmium ..... 110, 1002
ozokerite ..... 111
palladium ..... 110, 1002
paraffin ..... 111
peat ..... 111
petroleum ..... 111
phosphates ..... 111
pig iron ..... 110
platinum ..... 110, 990
potassium chloride ..... 111
sulphide ..... 111
pumice ..... 111
pyrite ..... 111
quicksilver ..... 110, 919
rhodium ..... 110, 1003
salt ..... 111
sand and gravel ..... 111
sienna and umber ..... 111
silver ..... 112, 218
slate ..... 111
sodium nitrate ..... 111
spiegeleisen ..... 110, 161, 200
strontium oxide ..... 111
sulphur ..... 111
talc ..... 111
tantalum ..... 960
thorium nitrate ..... 111
tin ..... 110, 970
titanium ..... 110, 954
tungsten ..... 110, 161, 948
type metal ..... 110
uranium salts ..... 110, 952
vanadium ..... 110, 951
venetian red ..... 111
zinc ..... 110, 379
oxide ..... 111, 381
India, bauxite ..... 924
chromite ..... 985
gold ..... 215
iron ore ..... 140

Page.

India, manganese ore, imports from ... 195
production ... 196, 206
tungsten ... 944
Indiana, bismuth ... 976
pig iron ... 154
value of mineral products ... 12, 33
Indo-China, gold ... 215
Infusorial earth and tripoli, summary ... 99, 111
Iowa, cooperation ... 8
lead ... 320
silver, copper, lead, and zinc (mine production) by J. P. Dunlop ... 805
value of mineral products ... 12, 34
zinc ... 355
Iridium, imports ... 1001
(*See* Platinum and allied metals.)
prices ... 1001
production ... 1001
summary ... 95, 111
uses ... 1001
Iron. (*See* Pig iron and steel.)
Iron ore, pig iron, and steel, by Ernest F. Burchard ... 119–175
apparent annual consumption ... 130
bibliography ... 168
Cuba, shipments from ... 139
curve showing production of iron ore, pig iron, and steel, 1870–1911 ... 121
curve showing production of pig iron in 1907, 1908, 1909, 1910, and 1911, by months ... 157
electric smelting ... 161
exports ... 138
imports, by countries ... 110, 137
iron-ore industry of United States ... 120
Lake Superior district ... 121, 132
prices ... 135
production by ranges ... 132
ranges ... 133
shipments, by ports ... 133
Michigan, reserves of ... 175
Mississippi Valley district ... 121
northeastern district ... 121
price per ton, by States and varieties ... 129, 130
principal iron-ore mines ... 127
production ... 122
by geographic districts ... 120
by mining districts ... 124
by States ... 122
by varieties ... 124
total ... 126
comparative production of iron ore and pig iron ... 131
Pacific slope district ... 122
prospecting for iron ore ... 140
by pits and drills ... 140
by magnetic surveys and drills ... 144
rank of States as ore producers ... 123
receipts at Lake Erie ports ... 134
Rocky Mountain district ... 121
southeastern district ... 121
stocks at lower lake ports ... 134
at mines, by States ... 129
summary ... 92, 110
value, by States ... 122
world's production ... 140

Page.

Iron ore reserves of Michigan in 1911, by C. K. Leith ... 175
Michigan iron-ore situation ... 176
methods used in making estimates ... 178
Gogebic district ... 182
Iron River district ... 183
Crystal Falls district ... 185
Menominee district ... 186
Marquette district ... 187
Swanzy district ... 189
Iron Ridge area, iron ore ... 132
Italy, bauxite ... 924
copper ... 313
exports to ... 310
gold ... 215
iron ore ... 140
lead ... 335, 343
manganese ore ... 196
quicksilver ... 917, 918
tungsten ... 944
zinc ... 377, 386

J.

Japan, chromite ... 980, 985
copper ... 313
imports from ... 309
gold ... 215
iron ore ... 140
lead ... 335, 343
manganese ore ... 195, 196
tungsten ... 944
Java, manganese ore ... 196

K.

Kansas, cooperation ... 8
lead ... 320
silver, copper, lead, and zinc (mine production), by J. P. Dunlop ... 806
value of mineral products ... 12, 35
zinc ... 355
Kaolin, imports, summary ... 111
Kentucky, cooperation ... 8
iron ore ... 122
lead ... 320
pig iron ... 154
silver ... 223, 229
copper, lead, and zinc (mine production), by J. P. Dunlop ... 810
value of mineral products ... 12, 37
zinc ... 355
Korea (Chosen), gold ... 215
quicksilver exports to ... 919

L.

Labrador, iron ore, imports from ... 137
Lake Erie ports, iron ore ... 134
Lake Superior, copper ... 291, 811
iron ore ... 126, 132
prices ... 135
production by ranges ... 132
ranges ... 132
shipments ... 133
stocks ... 133
manganiferous iron ore ... 197
Lead, by C. E. Siebenthal ... 315–352
antimonial ... 317, 322
bibliography ... 351

Page.

Lead, Canadian lead bounty ..... 349
comparison of smelter and mine returns.. 324
consumption ..... 341
by countries ..... 343
content of ore, by States ..... 328
convention ..... 350
customs duties ..... 339
desilverized ..... 317, 321
exports ..... 110, 338
from foreign ore ..... 320
imports ..... 110, 335
by countries ..... 337
industry, state of ..... 315
Lead, metallurgy ..... 332
concentration and separation ..... 332
smelting ..... 332
list of smelters ..... 332
new smelters ..... 333
smelter smoke ..... 334
pigments ..... 323
summary ..... 111
prices ..... 344
curves ..... 345
production, 1825–1911 ..... 316
curves ..... 317
by States ..... 318, 320
of refined or pig ..... 317
resources, mine production ..... 327
review by districts ..... 329
Central States ..... 329
Eastern States ..... 329
Western States ..... 331
secondary ..... 323
smelter and mine, State totals ..... 326
soft ..... 320
statistics, summary of ..... 351
summary ..... 93-110
of statistics ..... 351
trade conditions ..... 334
use in United States ..... 343
value ..... 344
warehouse transactions ..... 335
world's consumption ..... 343
production ..... 334
Leaded zinc oxide ..... 359
Leith, C. K., iron-ore reserves of Michigan in 1911 ..... 175
Lime, summary ..... 98, 111
Lindgren, Waldemar, paper on platinum and allied metals ..... 987
Lithium minerals, summary ..... 100
Lithopone ..... 359
Lorain, Ohio, receipts of iron ore ..... 135
Louisiana, value of mineral products ..... 12, 39
Low-phosphorus iron, production ..... 158
Luxemburg, iron ore, production ..... 140

M.

Macedonia chromite ..... 983
Magnesite, summary ..... 103
Maine, gold, silver, copper, lead, and zinc in Eastern States (mine production) 880
manganiferous ore ..... 197
molybdenum ..... 955
tin ..... 967
value of mineral products ..... 13, 40
zinc ..... 355

Page.

Malay States, tin ..... 971
tungsten ..... 944
Malleable Bessemer pig iron ..... 158
Manganese and manganiferous ores, by Ernest F. Burchard ..... 191–208
ferromanganese ..... 199
imports ..... 200
prices ..... 200
imports, by countries ..... 195
by customs districts ..... 195
notes on domestic ore ..... 202
foreign ore ..... 203
prices ..... 192, 194, 199
production ..... 191
by States ..... 192
sources of manganese ..... 200
list of principal minerals ..... 200
silicospiegel ..... 200
Spiegeleisen ..... 199, 200
stock ..... 194
summary ..... 93, 111
uses ..... 202
value ..... 191
world's production ..... 196
manganiferous ores ..... 197
(*See* Manganese ore.)
silver ores ..... 201
manganiferous zinc residuum ..... 198
production, by States ..... 197
summary ..... 93
Marble and stone, summary ..... 99, 111
Marquette, shipment of iron ore ..... 133
Marquette range, iron ore ..... 132
Maryland, cooperation ..... 8
chromite ..... 981
copper ..... 256, 267
gold ..... 211, 223, 231
gold, silver, copper, lead, and zinc in Eastern States (mine production) ..... 880
iron ore ..... 122
pig iron ..... 154
platinum ..... 997
silver ..... 211, 223, 231
value of mineral products ..... 12–13, 41
Massachusetts, chromite ..... 981
silver, copper, lead, and zinc in Eastern States (mine production) ..... 880
iron ore ..... 122
pig iron ..... 154
tin ..... 967
value of mineral products ..... 13, 42
Matawin range, iron ore ..... 132
McCaskey, H. D., paper on gold and silver in United States ..... 211–254
on gold, silver, copper, lead, and zinc in the Eastern States (mine production) ..... 873
on gold, silver, copper, lead, and zinc in the Western States (mine production), introduction ..... 209
on metals and metallic ores ..... 113–118
on quicksilver ..... 889
Menominee range, iron ore ..... 132
Merton & Co., Messrs., cited on copper production ..... 312

Page.

Mesabi range, iron ore ... 132
Metals and metallic ores, by H. D. McCaskey ... 113–118
production of metals ... 114
of ores ... 116
summary ... 92
Mexico, copper ... 313
imports from ... 309
gold ... 215
lead ... 320, 335
imports from ... 337
manganese ore ... 208
platinum ... 997
quicksilver ... 917
exports to ... 919
imports from ... 918
zinc ... 355, 369
ore, imports from ... 380
Mica, summary ... 103
Michigan, cooperation ... 8
copper ... 256, 267, 291
iron ore ... 122
reserves of, in 1911 ... 175
manganese ore ... 192
pig iron ... 154
silver ... 211, 223, 229
copper, lead, and zinc (mine production), by B. S. Butler ... 811
tin ... 969
value of mineral products ... 12, 44
Michipicoten iron range, Canada ... 132
Millstones and burrstones, summary ... 99
Mineral paints ... 101, 323, 359
Mineral production, summary of, by W. T. Thom ... 91–112
by substances ... 105
value, 1880–1911 ... 108
Mineral products of the United States, review of conditions and output in 1910 and 1911, by Edward W. Parker ... 7–90
character and scope of report ... 7
cooperation with State geological surveys. 7
historical review ... 9
individual States ... 16
leading States in mineral production ... 13
organization ... 8
raw and derived products ... 10
Mineral waters, summary ... 103
Minnesota, iron ore ... 122
manganiferous ore ... 197
pig iron ... 154
value of mineral products ... 12, 46
Mississippi, value of mineral products ... 13, 47
Missouri, cobalt ... 959
cooperation ... 8
copper ... 256, 267
iron ore ... 122
lead ... 320
manganese ore ... 192
pig iron ... 154
silver ... 211, 223, 229
copper, lead, and zinc (mine production), by J. P. Dunlop and B. S. Butler ... 826
tin ... 969
value of mineral products ... 12, 49
zinc ... 355

Page.

Molybdenum (*see also* Tungsten, etc) ... 955
imports ... 955
summary ... 94
Monazite and zircon, summary ... 103
and thorium oxide, summary ... 111
Montana, copper ... 256, 267, 294
gold ... 211, 223, 230
silver, copper, lead, and zinc (mine production), by V. C. Heikes ... 602
lead ... 320
manganese ore ... 192
manganiferous ore ... 197
platinum ... 997
silver ... 211, 223, 230
tin ... 967
tungsten ... 941
value of mineral products ... 12, 50
zinc ... 355

N.

Namaqualand, copper ... 313
Natural gas, summary ... 97
Nebraska, value of mineral products ... 13, 51
Netherlands, copper, exports to ... 310
iron ore, imports ... 137
manganese ore, imports ... 195
Nevada, copper ... 256, 267, 297
gold ... 211, 223, 230
silver, copper, lead, and zinc (mine production), by V. C. Heikes ... 646
lead ... 320
manganese ore ... 192
platinum ... 997
quicksilver ... 890, 905
silver ... 211, 223, 231
tungsten ... 941
value of mineral products ... 12, 53
zinc ... 355
New Caledonia, chromite ... 980, 982, 985
Newfoundland, copper ... 313
iron ore ... 140
imports from ... 137
quicksilver, exports to ... 919
New Hampshire, copper ... 256, 267
gold ... 223, 231
silver, copper, lead, and zinc in Eastern States (mine production) ... 881
lead ... 320
silver ... 223, 231
tin ... 967
value of mineral products ... 13, 54
New Jersey, cooperation ... 8
gold, silver, copper, lead, and zinc in Eastern States (mine production) ... 881
iron ore ... 122, 126
pig iron ... 154
value of mineral products ... 12, 55
zinc ... 355
residuum ... 198
New Mexico, bismuth ... 976
copper ... 256, 267, 299
gold ... 211, 223, 231
silver, copper, lead, and zinc (mine production), by Charles W. Henderson ... 702
iron ore ... 122, 126
lead ... 320
manganiferous ore ... 198

Page.

New Mexico, silver ... 211, 223, 231
tungsten ... 943
value of mineral products ... 13, 57
vanadium ... 950
zinc ... 355
New South Wales, chromite ... 985
platinum ... 998
tungsten ... 944
zinc ... 370
New York, gold, silver, copper, lead, and zinc in Eastern States (mine production) ... 881
iron ore ... 122
pig iron ... 154
platinum ... 997
value of mineral products ... 12, 59
New Zealand, chromite ... 980
tungsten ... 944
Nicaragua, quicksilver, exports to ... 919
Nickel (*see also* Tungsten) ... 956
exports ... 110, 958
imports ... 110, 957
production ... 956
summary ... 94
North Carolina, chromite ... 981
cooperation ... 8
copper ... 256, 267, 305
gold ... 211, 223, 232
gold, silver, copper, lead, and zinc in the Eastern States (mine production) ... 882
iron ore ... 122
manganese ore ... 192
manganiferous ore ... 198
platinum ... 997
silver ... 211, 223, 232
tin ... 966
uranium ... 952
value of mineral products ... 13, 61
North Dakota, value of mineral products ... 13, 62
Northern Territory, tungsten ... 944
Norway, copper ... 313
gold ... 215
iron ore ... 140
Nova Scotia, tungsten ... 944

O.

Ocher, summary ... 111
Ohio, iron ore ... 122
pig iron ... 154
steel ... 165
value of mineral products ... 12, 64
Oilstones and whetstones, summary ... 99, 111
Oklahoma, cooperation ... 8
lead ... 320
manganese ore ... 192
silver, copper, lead, and zinc (mine production), by J. P. Dunlop ... 857
value of mineral products ... 12, 65
zinc ... 355
Ontario, cobalt ... 959
nickel ... 956
Open-hearth steel ... 166
Oregon, cooperation ... 8
copper ... 256, 267, 305
gold ... 211, 223, 232
silver, copper, lead, and zinc (mine production), by C. G. Yale ... 721

Page.

Oregon, lead ... 320
platinum ... 995, 997
quicksilver ... 890, 910
silver ... 211, 223, 232
value of mineral products ... 13, 66
Osmium, imports ... 1002
(*See* Platinum and allied metals.)
price ... 1002
summary ... 95, 110
Ozokerite, summary ... 97, 111

P.

Palladium, imports ... 1002
(*See* Platinum and allied metals.)
prices ... 1002
production ... 1002
summary ... 95
uses ... 1002
Panama, quicksilver, exports to ... 919
Paraffin, summary ... 97, 111
Parker, E. W., mineral products, review of conditions and output in 1910 and 1911 ... 7-90
Peat, summary ... 97, 111
Pennsylvania, chromite ... 981
cooperation ... 8
copper ... 256, 267, 305
ferromanganese ... 199
gold ... 211, 223, 231
silver, copper, lead, and zinc in Eastern States (mine production) ... 884
iron ore ... 122
manganese ore ... 193
manganiferous ore ... 198
pig iron ... 154
silver ... 211, 223, 231
spiegeleisen ... 199
steel ... 165
value of mineral products ... 12, 71
Peru, copper ... 313
imports from ... 309
gold ... 215
tungsten ... 944
Petroleum, summary ... 97, 111
Phalen, W. C., paper on bauxite and aluminum ... 923
chromic iron ore ... 979
Philippine Islands, copper ... 256, 267
gold and silver ... 211, 223, 234
lead ... 320
manganese ore ... 196
quicksilver, exports to ... 919
Phosphate rock, summary ... 100
Pig iron and steel (*see also* Iron ore, iron and steel) ... 154
curve showing daily average production of pig iron, by months ... 157
electric smelting of iron ore ... 161
exports ... 110
ferroalloys ... 159
imports ... 92, 110, 161
prices ... 155, 159
production, by States ... 154
according to fuel used ... 158
blast furnaces ... 155
by kinds ... 158

Page.

Pig iron and steel, production, monthly ..... 156
total ..... 159
value ..... 154
steel production ..... 165
acid ..... 165
basic ..... 166
Bessemer ingots and castings ..... 165
electric ..... 167
open-hearth ingots and castings ..... 166
total ..... 167
summary ..... 92
Platinum and allied metals, by Waldemar Lindgren ..... 987
consumption ..... 991
impurities ..... 994
imports and exports ..... 990
metals ..... 991
determination of ..... 992
occurrence ..... 995
United States ..... 995
foreign countries ..... 997
prices ..... 989
production, domestic, crude ..... 987
refined ..... 987
from sands ..... 987
from gold and copper bullion ..... 988
from lode mines ..... 988
Canada ..... 1000
Colombia ..... 999
New South Wales ..... 998
Russia ..... 998
secondary ..... 991
summary ..... 95
uses ..... 995
world's production ..... 990
Poland, zinc ..... 377
Porto Rico, gold and silver ..... 211, 223
Portugal, copper ..... 313
gold ..... 215
tungsten ..... 944
Potassium salts, summary ..... 100
Prices, aluminum ..... 933
antimony ..... 975
bauxite ..... 923
bismuth ..... 976
cadmium ..... 401
chromite ..... 979
copper ..... 312
ferromanganese ..... 200
iridium ..... 1001
iron ore ..... 129
Lake Superior ..... 135
lead ..... 344
manganese ore ..... 194
manganiferous ore ..... 197
osmium ..... 1002
palladium ..... 1002
pig iron ..... 155, 159
platinum ..... 989
quicksilver ..... 920
rhodium ..... 1002
selenium ..... 977
silicospiegel ..... 200
silver ..... 213
spiegeleisen ..... 200
tin ..... 971
tungsten ..... 944

Page.

Prices, vanadium ..... 949
zinc ..... 387
dust ..... 388
Pumice, summary ..... 99
Pyrite, summary ..... 101, 111

Q.

Quartz, summary ..... 103
Queensland, manganese ore ..... 196
tungsten ..... 944
Quicksilver, by H. D. McCaskey ..... 889
bibliography ..... 920
condition of industry ..... 889
deposits, ores, and gangues ..... 893
deposits ..... 893
ores ..... 895
gangues ..... 898
exports ..... 110, 919
foreign mines and markets ..... 917
imports ..... 110, 918
prices ..... 920
production ..... 890
by States ..... 890
for decade ending 1911 ..... 891
number of mines, metal output, and value ..... 890
resources, occurrences, and development, by States ..... 898
Alaska ..... 916
Arizona ..... 898
California ..... 899
Idaho ..... 904
Nevada ..... 905
Oregon ..... 910
Texas ..... 912
Utah ..... 913
Washington ..... 916
summary ..... 94, 110
tariff ..... 917
tonnage and recovery ..... 891
world's production ..... 917

R.

Rhine district, zinc production ..... 394
Rhode Island, value of mineral products ..... 13, 72
Rhodesia, chromite ..... 981, 985
Rhodium, price ..... 1002
Canada ..... 1003
imports ..... 1003
summary ..... 95, 110
uses ..... 1002
Russia, chromite ..... 985
copper ..... 313
exports to ..... 310
gold ..... 215
iron ore ..... 140
imports from ..... 137
lead ..... 335, 343
manganese ore ..... 195, 196, 203
platinum ..... 998
quicksilver ..... 917
zinc ..... 386
Ruthenium ..... 1003
Rutile, summary ..... 95
(*See also* Tungsten.)

S.

Page.

Salt, summary ..... 101
Salvador, quicksilver, exports to ..... 919
Sand and gravel, summary ..... 98
Sand-lime brick, summary ..... 98
Sandusky, Ohio, receipts of iron ore ..... 134
Santo Domingo (Dominican Republic), quicksilver, exports to ..... 919
Selenium, by Frank Hess ..... 977
prices ..... 977
summary ..... 96
Servia, copper ..... 313
gold ..... 215
Siam, gold ..... 215
tungsten ..... 944
Siebenthal, C. E., paper on cadmium ..... 399–402
on lead ..... 315–352
on zinc ..... 353, 398
Sienna and umber ..... 111
Silesia, zinc ..... 394
cadmium ..... 400
Silicospiegel, prices ..... 200
Silver, Arkansas, by J. P. Dunlop ..... 798
distribution by States and sources of silver product ..... 246
by methods of treatment ..... 247
Illinois, by J. P. Dunlop ..... 801
Iowa, by J. P. Dunlop ..... 805
Kansas, by J. P. Dunlop ..... 806
Kentucky, by J. P. Dunlop ..... 810
Michigan, by B. S. Butler ..... 811
Missouri, by J. P. Dunlop ..... 826
Oklahoma, by J. P. Dunlop ..... 857
production by States ..... 211
(*See also* Gold and silver.)
summary ..... 93, 112
Wisconsin, by J. P. Dunlop ..... 863
Silver, copper, lead, and zinc in the Central States, by B. S. Butler and J. P. Dunlop (mine production in 1911):
bibliography ..... 871
introduction ..... 793
production ..... 794
by regions ..... 797
summary by States ..... 796
tenor of lead and zinc ores ..... 794
Singkep, tungsten ..... 944
Slate, summary ..... 98
Soapstone, summary ..... 104
Sodium nitrate, summary ..... 101, 111
South Africa, tin ..... 971
tungsten ..... 944
South America, copper, imports from ..... 309
lead ..... 320, 337
South Carolina, gold ..... 211, 223, 232
silver, copper, lead, and zinc in Eastern States (mine production) ..... 885
manganese ore ..... 193
manganiferous ore ..... 197
silver ..... 223, 232
tin ..... 966
value of mineral products ..... 13, 73
South Dakota, copper ..... 256, 267, 305
gold ..... 211, 223, 232
silver, copper, lead, and zinc (mine production), by Charles W. Henderson ..... 734

Page.

South Dakota, lead ..... 320
manganese ore ..... 193
silver ..... 211, 223, 232
tantalum ..... 960
tin ..... 967
tungsten ..... 941
value of mineral products ..... 13, 74
Spain, copper ..... 313
imports from ..... 309
gold ..... 215
iron ore ..... 140
imports from ..... 137
lead ..... 335
manganese ore ..... 196
quicksilver ..... 917
tungsten ..... 944
zinc ..... 377, 386
Spiegeleisen ..... 110, 158, 160
imports ..... 110, 161
(*See also* Manganese ore.)
Spring Valley area, iron ore ..... 132
Steel ..... 165
(*See* Pig iron and steel.)
Stone, summary ..... 99
Straits Settlements, tin ..... 971
Strontium oxide, summary ..... 111
Sudbury, Canada nickel ..... 956
ruthenium ..... 1003
Sublimed blue and white lead ..... 323
Sulphur, summary ..... 101, 111
Sulphuric acid from smelters, summary ..... 101
Sumatra, platinum ..... 990
Summary of mineral production compiled by W. T. Thom ..... 91–112
curve showing value of mineral products, 1880–1911 ..... 109
exports ..... 108–112
general remarks ..... 91
abrasive materials ..... 99
chemical materials ..... 100
fuels ..... 96
imports ..... 108–111
metals and ores ..... 92
miscellaneous ..... 102
pigments ..... 101
structural materials ..... 97
table of mineral products, 1910–11 ..... 105
value of, from 1880 to 1911 ..... 108
Superior, shipments of iron ore ..... 133
Swank, James M., acknowledgments to ..... 104
Sweden, copper ..... 313
gold ..... 215
iron ore ..... 140
imports from ..... 137
lead ..... 335
manganese ore ..... 196
Switzerland, lead ..... 343

T.

Talc and soapstone, summary ..... 104
Tantalum ..... 960
imports ..... 960
summary ..... 95
Tasmania, chromite ..... 980
copper, imports from ..... 309
tungsten ..... 944

Page.
Tellurium, summary ..... 96
Tennessee, bauxite ..... 923
copper ..... 256, 267, 301
gold ..... 211, 223, 232
silver, copper, lead, and zinc in Eastern States (mine production) ..... 885
iron ore ..... 122
lead ..... 320
manganese ore ..... 192–193
manganiferous ore ..... 197
pig iron ..... 154
silver ..... 211, 223, 232
value of mineral products ..... 12, 76
zinc ..... 355
Texas, cooperation ..... 8
copper ..... 256, 267
gold ..... 211, 223, 233
silver, copper, lead, and zinc (mine production), by Charles W. Henderson ..... 739
iron ore ..... 122
lead ..... 320
pig iron ..... 154
quicksilver ..... 890, 912
silver ..... 211, 223, 233
tin ..... 968
value of mineral products ..... 12, 78
zinc ..... 355
Thom, W. T., compilation of summary of mineral production of the United States in 1911 ..... 91–112
Thorium nitrate, summary ..... 103, 111
Tin, by Frank L. Hess ..... 963
bibliography ..... 972
imports ..... 970
occurrence, by States ..... 963
prices ..... 971
production ..... 963
secondary ..... 970
summary ..... 96, 110
tests of cassiterite ..... 969
world's supply ..... 971
Titanium (*see also* Tungsten) ..... 954
imports ..... 954
production ..... 954
summary (rutile) ..... 95
uses ..... 954
Toledo, Ohio, receipts of iron ore ..... 134
Tripoli ..... 99, 111
Tungsten, by F. L. Hess ..... 941
bibliography ..... 961
imports ..... 948
ore industry, by States ..... 941
prices ..... 944
production ..... 943
summary ..... 95
uses ..... 945
world's production ..... 944
Tunis, iron ore ..... 140
Turkey, chromite ..... 980, 985
copper ..... 313
gold ..... 215
lead ..... 335
manganese ore ..... 196
Two Harbors, shipments of iron ore ..... 133
Type metal, imports ..... 110, 337

U.

Page.
United Kingdom, bauxite ..... 924
copper, exports to ..... 310
imports from ..... 309
iron ore ..... 140
imports from ..... 137
lead, imports from ..... 337
manganese ore ..... 196
imports from ..... 195
Ural Mountains, platinum ..... 998
Uranium (*see also* Tungsten) ..... 952
imports of salts ..... 953
summary ..... 95, 110
Uruguay, gold ..... 215
Utah, alunite ..... 924
bismuth ..... 976
copper ..... 256, 267, 302
gold ..... 211, 223, 233
silver, copper, lead, and zinc (mine production), by V. C. Heikes ..... 740
lead ..... 320
manganese ore ..... 193
platinum ..... 997
quicksilver ..... 890, 913
silver ..... 211, 223, 233
tin ..... 969
value of mineral products ..... 12, 80
vanadium ..... 950
zinc ..... 355

V.

Value of mineral products, by States ..... 12, 16–90
by substances ..... 105
total ..... 108
Vanadium (*see also* Tungsten, etc.), condition of industry ..... 949
imports ..... 951
production ..... 949
summary ..... 95
use ..... 951
Venetian red, summary ..... 111
Venezuela, gold ..... 215
quicksilver, exports to ..... 919
Vermilion range, iron ore ..... 132
Vermont, copper ..... 256, 267
gold, silver, copper lead, and zinc in Eastern States, (mine production) ..... 887
manganese ore ..... 193
manganiferous ore ..... 198
value of mineral products ..... 13, 82
Victoria, tungsten ..... 944
Virginia, cooperation ..... 8
copper ..... 256, 267
gold ..... 211, 223, 232
silver, copper, lead, and zinc in Eastern States (mine production) ..... 887
iron ore ..... 122
lead ..... 320
manganese ore ..... 192–193
manganiferous ore ..... 197
pig iron ..... 154
silver ..... 211, 223, 232
tin ..... 968
titanium (rutile) ..... 954
value of mineral products ..... 12, 84
zinc ..... 355

W.

Page.

Washington, cooperation ..... 8
copper ..... 256, 267, 305
gold ..... 211, 223, 234
silver, copper, lead, and zinc (mine production), by C. N. Gerry ..... 778
iron ore ..... 122
lead ..... 320
pig iron ..... 154
platinum ..... 997
quicksilver ..... 890, 916
silver ..... 211, 223, 234
tin ..... 969
tungsten ..... 941
value of mineral products ..... 12, 86
zinc ..... 355
Wavellite, Alabama ..... 937
West Indies, platinum ..... 997
manganese ..... 208
West Virginia, iron ore ..... 122
manganese ore ..... 193
pig iron ..... 154
value of mineral products ..... 12, 88
Western Australia, tungsten ..... 944
Whetstones, summary ..... 99
Wisconsin, cooperation ..... 8
iron ore ..... 122
lead ..... 320
pig iron ..... 154
silver, copper, lead, and zinc (mine production), by J. P. Dunlop ..... 863
value of mineral products ..... 12, 89
zinc ..... 355
World's production, bauxite ..... 924
chromite ..... 985
copper ..... 312
gold ..... 214
iron ore ..... 140
lead ..... 334
manganese ore ..... 196
platinum ..... 990
quicksilver ..... 917
tin ..... 971
tungsten ..... 944
zinc ..... 377
Wyoming, chromite ..... 981
copper ..... 256, 267, 305
gold ..... 211, 223, 234
silver, copper, lead, and zinc (mine production), by Charles W. Henderson ..... 788
iron ore ..... 122
platinum ..... 997
silver ..... 211, 223, 234
value of mineral products ..... 12, 90

Y.

Yale, Charles G., paper on gold, silver, copper, lead, and zinc in California (mine production) ..... 462
Oregon (mine production) ..... 721

Z.

Page.

Zinc, by C. E. Siebenthal ..... 353
bibliography ..... 396
comparison of smelter and mine returns ..... 362
condition of industry ..... 354
consumption ..... 385
grades ..... 387
in United States ..... 385
uses ..... 386
world's ..... 386
content of ore ..... 365
convention ..... 394
curve of production and consumption ..... 357
customs duties ..... 383
districts, zinc producing ..... 366
Central States ..... 366
Eastern States ..... 366
Western States ..... 367
dross, exports of ..... 361
dust ..... 358
exports ..... 110, 382
imports ..... 110, 379
Joplin ore scale ..... 393
lead ..... 323
metallurgy ..... 371
concentration and separation ..... 371
smelting ..... 372
chemical ..... 372
electrothermic ..... 372
retort ..... 374
smelters ..... 374
changes ..... 376
list of ..... 375
mine and smelter, totals ..... 364
ore, imports from Canada and Mexico ..... 380
oxide ..... 359
imports and exports ..... 380, 381, 382
summary ..... 102
pigments ..... 359
prices ..... 387
curves ..... 389
production ..... 354
annual, 1873–1911 ..... 354, 356
by location of smelter ..... 356
by States ..... 355, 365
residues ..... 320
residuum ..... 198
resources, mine production ..... 364
Australia ..... 370
Canada ..... 369
Mexico ..... 369
United States ..... 365
secondary zinc ..... 360
chloride from, as wood preservative ..... 361
smelter and mine, totals ..... 364
summary ..... 93
of statistics ..... 395
trade conditions ..... 377
uses ..... 386
value ..... 389
warehouse transactions ..... 378
world's consumption, by countries ..... 386
production, by countries ..... 377
Zinc-lead ..... 323
Zircon, summary ..... 102